SCIENCE REPORTER

VOL. 12 NOVEMBER 1975 NO. 11

512	1 1 1 1	TERS
317		1000

MAIN ARTICLES

514 Materials for modern acrospace and
Oceanspace vehicles

519 On computer design

525 Antitranspirants reduce water needs
in agriculture

530 Prawns: How to increase their production

Usha Goswami

533 Heart lung machines

J.P. Gupta

539 SCIENCE SPECTRUM

Moon's origin still a puzzle Friendly or amicable numbers. History of non-Euclidean geometry. What cosmetics are made of Desalination of water: a novel technique. Biochemistry of alcoholism—Sunflower—an ideal source for oil. Sexual parasitism

555 NEWS AND NOTES

Basic unit of magnetism detected INSA award winner -1974

556 MEDICAL NOTES

Is rice tabou for the diabetic? - Antiestrogens

- 559 PLANETS AND THEIR POSITIONS-DECEMBER 1975
- 560 SCIENCE FOR THE YOUNG

 Meeting future energy demands— How fluorescent lamp works—
 Believe it or not
- 565 SCIENCE IN INDUSTRY

Sodar- acoustic waves that detect atmospheric variations- Technology developed for pine needles

568 BOOK REVIEWS

Advance Bractical Organic Chemistry. The Invisible Universe-

cience Reporter is issued monthly. he Council of Scientific & Industrial tenearch assumes no responsibility or the statements and opinions dvanced by contributors.

Annual Subscription

Inland .: Rs. 10.00 Foreign ! \$ 5.00

LETTERS

Cyclic nucleotides

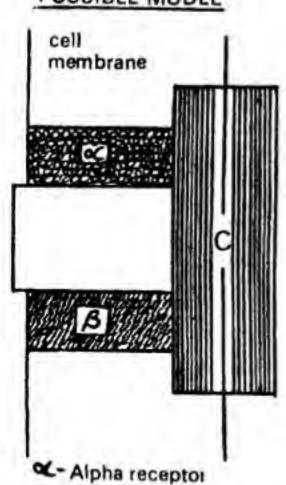
Sir, Thanks for the informative and interesting article Cyclic nucleotides by Harish D. Padh and K.D. Dhariwal (S.R. July, 1975). We would like to know the role of catecholamines, if any, in the action of cyclic-AMP.

P. MAHAJAN
J. DATWANI
Machali Khadak, Aurangabad
(Maharashtra)

Instead of looking at the role of catecholamines in the action of cyclic AMP, it would be useful if role of cyclic-AMP in the action of catecholamines is understood.

Catecholamines and prostaglandins act by either increasing or by decreasing the level of cyclic-AMP and in this manner they differ from other formones with regard to their effect on cyclic-AMP. Effects mediated by an increase in the level of cyclic-AMP include several effects on carbohydrate metabolism, lypolytic effect,

POSSIBLE MODEL



B- Beta receptor

C - Catalytic unit

relaxation of smooth muscle, etc. These effects seem to be caused by stimulation of adenyl cyclase.

Other effects, which may be due to inhibition of adenyl cyclase and thus decrease in cyclic-AMP levels, are inhibition of insulin secretion by pancreatic beta cells, reduced permeability to water and electrolytes in several epithelial tissues, stimulation of platelet aggregation and inhibition of melanophore dispersion in frog skin.

A possible model with much experimental support can explain these diverse effects. There may be two types of hormone receptors, alpha and beta, connected separately to the two different regulatory subunits of adenyl cyclase. The effective interaction of catecholamines with alpha-receptor may lead to a decrease in the enzyme activity and their association with beta-receptor may lead to an increase in enzyme activity.

HARISH D. PADH K.D. DHARIWAL Department of Biochemistry Vallabhbhai Patel Chest Institute University of Delhi Delhi-110007

To chew or not to chew

Sir, To chew or not to chew (S.R. July, 1975) was interesting and informative. R.K. Trikha tried to give some historical facts and also how chewing gums are prepared. The question whether one should chew or not remains unanswered. He should say categorically whether it is good or bad.

G.M. Govt. Hr. Sec. School Shahdara, Delhi

Gum chewing is not a wholesome habit. It can cause several ill effects. Besides, it does not provide nourishment to the chewer.

R.K. TRIKHA

Deptt. of Chemistry

Hans Raj College

Delhi University, Delhi

Viscosity bridge

Sir, This is regarding Viscositive bridge (S.R. May, 1974). The application of Wheatstone Bridge principle in designing an instrument for viscosity needs to be commended. Please let us know if such a unit function in any laboratory and if you can sen further details.

We in the sugar industry encounter thick molasses and syrups of the order of 500-1500 poise which are non-Newtonian. You may also advise suitable modifications if required in the design of the apparatus

V.V. SUBBARA Chief Chemist (R & D Somaiya Sugar Work Bijapur Distt. (Karnataka

In the article, I suggested a possible method to determine viscosity based on the general principle of the Wheat stone Bridge. I feel that the method can be applied to any specimen with suitable choice of components to cover different ranges of viscosity Built with ground glass joints, the capillaries constituting the bridge can be suitably chosen to match with the specimen at any suitable ratio. But thick specimens of the type mentioned may offer such difficulties as are observed with a P.O. Box in the determination of high resistances.

A.O. MATHA Physics Deptt. M.A. College Kothamangalam (Kerala)

П

Sir, The viscosity of liquidal decreases, and that of gases increases with temperature. In text books some empirical relations are given for the former with no theoretical explanation. I shall be highly obliged if you kindly publish an article on "Variation of viscosity with temperature."

A.K. CHAKRAVORTY

Deptt. of Physics

B.B. College, Asanson

Son or daughter

Sir, The article Son or daughter? by lyotirmoy Dasgupta (S.R. April, 1975) was interesting and informative. The author has presented the subject in a simple and lucid way such that even a layman can understand and appreciate it.

> B.P. KHARE Professor, Chemistry Deptt. Govt. College, Balaghat (M.P.)

Planet chart

Sir, I was deeply disappointed that you did not give Planets and their positions in May and June 1975 issues. I could not put it up on our school (Campion School, 13, Cooperage Road, Bombay-39) notice board. Please do not omit that important piece in future.

A.W. MENEZES Bandra, Bombay

Suggestions

1

Sir, I read S.R. with profound interest. As a science student, I find t quite informative and interesting. Protein synthesis in S.R. May, 1975 was very useful for B.Sc. and M.Sc. students. Due to non-availability of clear description and diagrams in books, students found the article particularly helpful for their university examination.

I request you to publish an article on "Gene synthesis".

D.P.S. TEOTIA Meerut (U.P.)

11

Sir, I read S.R. regularly and with nuch interest. As a research scholar find this magazine of great help to ne.

I would like you to publish an rticle on the modern concept of tomic structure and recent discover-

Article on TV Broadcasting in

S.R. August, 1975 was also of great help.

New India Colony, Agra

ш

I request you to publish articles on dental science and oral hygiene.

Dr. R. Ahmed Dental College and Hospital, Calcutta

Petrochemicals

Sir, Dr. Sukumar Maiti is entitled to his views 'On petrochemicals' (S.R. Sept., 1975, pages 401, 415) as against those of people in trade and government departments, but I think there is little justification for his concluding remark. "This type of undesirable twisting of chemical fact or narrowness in classification of chemicals reflects the lack of proper perspective and may be found in bureaucractic systems which argue that caprolactum is a petrochemical but nylon-6 is not, only to justify the difference in amount of tax to be levied on them". Perhaps he may not know that the boot is on the other leg. To illustrate, when it is the question of obtaining depreciation on plant and machinery at 15% as against the general rate of 10%, manufacturers of synthetic fibres claim that they are manufacturing "artificial silk", but when it comes to seeking some extra benefit as a priority industry, the same manufacturers claim that they are engaged in the manufacture of "petrochemicals". It is stated at page 187, Vol. 10, chapter on "Petroleum chemicals" in Encyclopedia of Chemical Technology edited by Kirk and Othmer that "Petrochemicals have become vital raw materials for the rapidly growing synthetic fibre industry". It is also stated at page 328 in The Wealth of India-Raw Materials, Vol. VII, published by the Council of Scientific and Industrial Research, New Delhi (1966) under the sub-title 'Petrochemicals' that "Petrochemi-

cals are the primary and intermediate compounds made from the basic hydrocarbons derived from petroleum or natural gas. These hydrocarbons have now become the larges source of organic chemicals. They have undisputed sway in the field of aliphatic chemicals, though derivatives of aromatics are made from both coaltar and petroleum sources. The basic hydrocarbons are processed to produce a large range of products which include synthetic, textiles, etc." As stated by Dr. Maiti himself (S.R. September, 1975), polymers are derived from "Petroleum intermediates" (not from petroleum or natural gas) and he further admits that there are "apparent anomalies between ordinary chemical compounds and polymeric materials."

Dr. Maiti says "polymers should be considered as chemical compounds or a special class of compounds" just as Shri P.N. Maitra in his letter (S.R. August, 1975) argued "The term petrochemicals should cover not only basic organic chemicals but also synthetic fibres, plastic, elastomers and other end products based on petrochemical feed stock." What I want to point out is that "what should be" is quite different from "what it is" and that people in trade and government departments are more interested in "what it is". The difference between the two may be illustrated by one simple example. Nylon-6 in filament form is woven in fabrics, after which it is used in the form of garments. If Nylon-6 in filament form is considered a petrochemical on a par with caprolactam (from which it is derived after undergoing an elaborate process of polymerisation during which there are physical and chemical changes). why it must not be treated as a petrochemical in its subsequent form of fabrics as well (when there occurs no change in its chemical composition)? But is there any one who

(Continued on page 518)

MATERIALS FOR MODERN AEROSPACE AND OCEANSPACE VEHICLES



HEM SHANKER RA

Technological advances in our era are largely dependent on the properties of available materials. Newer metallic and nonmetallic materials are being developed continuously to meet the difficult requirements. Vehicles and their components made of such materials are required to be stable under various adverse conditions. They need materials which can withstand very high temperatures and pressures, wide temperature fluctuations, nonuniform distribution of temperature and pressure over the body. The materials of construction must also be suited to fabrication

processes such as rolling and joining processes such as welding. The presence of a crew in manned vehicles complicates matters further, since the vehicles must contain a life sustaining environment over extended periods. Oxygen in the vehicle must not leak or be consumed by the materials.

A supersonic aircraft

Consider, for example, a Machesupersonic aircraft schematicall shown in Fig. 1. The outer surfaces of such a fast moving aircraft are considerably heated up because of the a friction. Friction can be minimize to some extent by better design but cannot be eliminated. The diagram

For progress in spaceships, missiles, rockets or supersonic air craft, suitable engineering materials are required for construction. A special type of material is also required for diving vehicles for exploration of deep seas

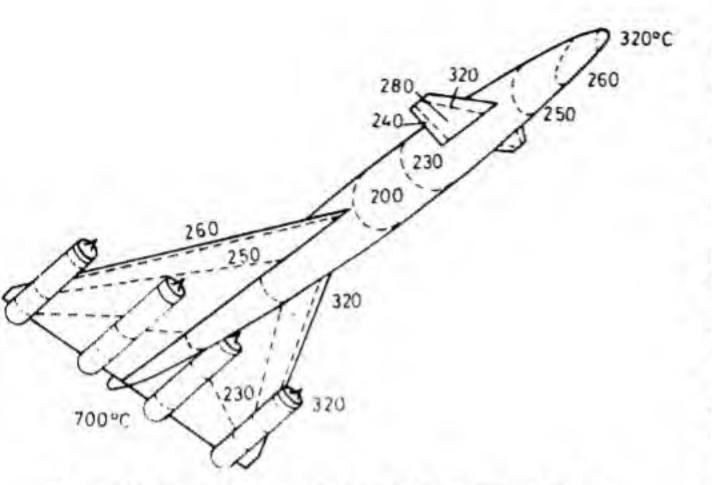


Fig. 1. Peak external skin temperatures for a Mach 3 supersonic transport

idicates some typical skin temperaires for such high speeds. The ighest temperatures are found near ne exhausts from where hot jets are ected. The uneven temperature istribution on the fuselage leads to onsiderable thermal stresses which turn would lead to weakening of rength. Rise in temperature also chances oxidation of materials by the air environment. This happens missiles and rockets.

spaceship

Material problems assume great agnitude in space ventures such the Apollo spacecraft (Fig. 2). he spacecraft has three main ctions. During ejection into pace, the problems are similar those discussed earlier. However, e most severe challenge is enountered during re-entry into the mosphere. The service module hich contains the propellant tanks, ectrical generating equipment, naller rocket engines for midcourse anoeuvres and retrofire, etc., is ttisoned before the command odule enters the atmosphere. It therefore, not protected with plative materials and so burns up in e earth's atmosphere during retry. The command module, which

carries the crew in a double shell pressure vessel must, however, be protected during re-entry for obvious reasons. The nose cap of this module has to withstand temperatures as high as 2000 °C. Combination of ceramic materials and refractory metals may give adequate protection to the nose cap and other forward areas. The rest of the vehicle, which supports these very high temperature materials and takes the aerodynamic and thermal stresses, is made of superalloys (mostly nickel-based alloys) to withstand expected temperatures of 600 °C-1200 °C.

Thermal stresses

Consider a high speed aircraft. The total skin area of the plane may be as large as 2000 sq. m. The plane may take off from a tropical region at 45 °C and reaches, in minutes, an altitude of 20,000 m where it is as cold as -60 °C. Near oceans the surface may be sprayed with salt. These as well as the motions of the plane generate various stresses over the body. In general, thermal stresses are lower when heat conductivity is higher. All kinds of stresses can be minimized by using a better structural design.

Creep and fatigue

The material may 'creep', i.e., fail

slowly even at low stresses if the stress period is extended. Also, repeated cyclic loading often cause material failure due to the phenomenon of 'fatigue'. Such dangers exist for all aerospace vehicles.

Material losses

Gross evaporation of material is no problem for short duration flights, except for zinc and cadmium which have low boiling points. Such metals should be avoided. For permanent space stations and prolonged flights the question of evaporation may become serious. In spaceships filled with oxygen there may be oxidation of the interior. Thus titanium which is very reactive is avoided and aluminium and magnesium alloys preferred. Stainless steel is even better. Various radiations in space, fortunately, hardly affect the structural metals.

Meteoroid protection

The protection of spacecrafts from meteoroids is primarily a design problem depending only on materials selection. Light structural alloys are better meteoroid shields than denser metals. On an equal weight basis, a sheet of light metal suffers less relative penetration than a sheet of heavy metal. Also, all shields must be ductile.

Connected closely with this question is that of spalling, which means ejection of particles at high velocity from the back surface of a plate struck by a meteoroid. This phenomenon depends on propagation of shock waves through the shield. Spalling is often eliminated by using laminated structures.

Heat transfer

The question of transfer of heat from one part of the body to another and from the body to the environment is of great importance in aerospace. The former is essential for proper energy balance.

Consider, for example, generation of heat in a vehicle in space. An electronic equipment or some physithe source. The outer surface of the vehicle gains heat through internal sources as well as through solar radiation. All heat gained must be dissipated into space to maintain a steady skin temperature. To control absorption and dissipation of heat, special surface coatings are employed. No single coating can offer accurate control of the ratio of absorption and dissipation. 'Mosaics' of two or three surface coatings may be needed.

Alloys

We will mainly consider metallic materials which go to make the bulk of the vehicles. The categories are: aluminium and magnesium alloys, titanium alloys, steel alloys and super alloys.

Alloys based on aluminium and magnesium are particularly attractive because of their lightness. However, their strength falls rapidly at elevated lemperatures. Aluminium-beryllium alloys are also noted for lightness and strength at low temperatures. In addition to lightness, these alloys may be additionally attractive because of their low cost and formability. Other light alloys based on titanium containing small amounts of aluminium and vanadium among other metals) are stronger. They also retain strength upto a higher temperature. 450 °C.

Improved strength, fatigue and creep resistance, corrosion resistance, etc., are obtained in steels by using various proportions of alloying elements such as nickel, chromium, manganese, etc. Super alloys are nickel, cobalt and iron base alloys which at first glance might not appear attractive. They are expensive and difficult to form. However, they withstand high temperatures better.

Iron base super alloys contain large amounts of nickel and cobalt, say 20 or more per cent of each, with small amounts of other metals (Ti, Mo, Al, Si, Mn, etc.). Nickel base super alloys often contain 5 per

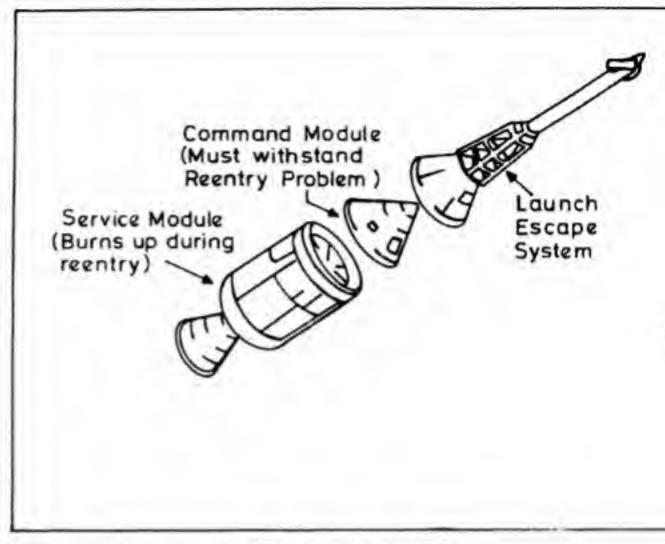


Fig. 2 Apollo spacecraft

cent-15 per cent each of Cr. Mo. Co, Ti and Al. Small amounts of B, Cd, Fe, Zr, W, etc., may also be present. Cobalt base super alloys contain 10 per cent or more of Ni, Cr and W with small amounts of Mo, Fe, etc. All individual alloying elements play special role in imparting desirable properties.

One of the most important properties for comparison of structural materials is the strength-to-weight ratio. For the same cross sectional thickness a material with a higher ratio would have higher strength. Or, in other words, for equal weight, the component would be stronger. The light structural alloys are attractive from this point of view. At room temperature, aluminium-magnesium alloys can have a maximum value, about twice that of stainless steels and super alloys. Titanium alloys and beryllium-aluminium alloys are even better. The lighter alloys have a distinct advantage at low temperatures. Many composites, e.g., glass filament reinforced resins or steel filament wound ceramics are even better. Fig. 3 shows that many conventional lloys based on Be, Al, Mg or Ti have

a high strength/weight ratio at low temperatures only. The advantage lost at higher temperatures who only the heavy alloys retain streng The differences which apparer seem marginal assume critical impartance in aerospace applications.

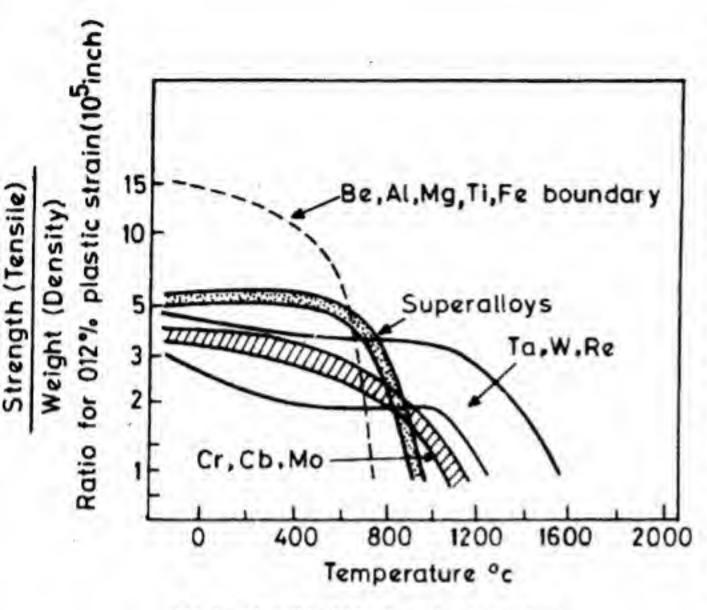
Rating procedure

To rate an alloy, the characterist are divided into three categories. It first category embodies these requirements which must be met if a material to be considered at all. The parameters are availability, formability and producibility.

In the second category, one incluthose parameters which must be



"True, your new material stand rigours of intense heat and cold, wa and air, but what we need is a mater that can stand the rigours of our road



(Fig. 3. Strength/weight ratio against temperature

hey are weldability and corrosion esistance in the expected environments. In certain cases, brazing rocess of joining two pieces of netal by fusing a layer of brass between the two surfaces is also important.

The third category of rating characeristics includes a list of important parameters which can be denoted quantitatively and are interchangeable to some extent. They are the minimum values of tensile and compressive strength over a range (say from room temperature to 350°C), fatigue and creep resistance, weld strength, thermal stress characteristics, stiffness, material toughness, structural stability, cost, etc. These properties are measured using standardized tests.

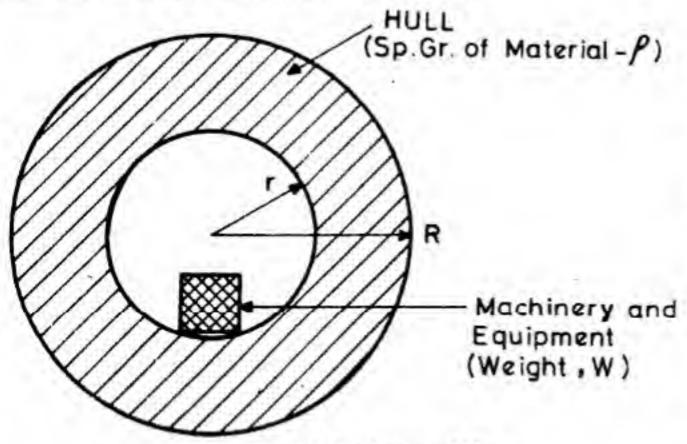


Fig. 4. A spherical underwater vehicle

Materials for oceanspace vehicles

In recent years scientific, military and economic necessities have led to tremendous activities in exploration of the seas. Many sea-floors are now known to have deposits of man ganese nodules and other valuable metal and mineral deposits. The can be retrieved only by going to the deep areas.

The two main problems that an underwater vehicle faces are: the hydrostatic pressure and sinking and floating. Resistance to pressure may be enhanced by means of stronge and heavier hulls. However, this may impair floatability. Ideally, the vehicle must be in a delicate hydrostatic balance. Along with strength of hull and hydrostatic balance on must also ensure adequate space inside the hull for life support and machinery. These problems are all interrelated.

Consider a spherical vehicle a shown in Fig. 4. If the vehicle b in a perfect hydrostatic balance then

$$W + \frac{4}{3}\pi(R^3 - r^3) = \frac{4}{3}\pi R^3$$

It is obvious that for a given valu of vehicle size R and machinery weigh W, r is larger (i.e., usable space insid is greater) for denser materials Within limits, the thickness of an material used for hulls may be in creased to attain greater depths However, this will be achieved at the cost of decrease in either Worr. Thi increases hull fraction which is define as the per cent buoyancy used up by the hull weight. Most of the vehicle are designed for a hull fraction o 60 per cent-70 per cent. The only wa to obtain greater depths while main taining or lessening the hull fraction is to increase the strength-to-densit ratio of the hull material. This ratio effects the critical vehicle character istics-depth, size, speed, range, pay load, etc. Therefore, selection of th hull material comes first.

It should be remembered that under water localized concentration of

hydrostatic stress can lead to material failure rather abruptly. Materials sensitive to fractures and cracks will be more prone to such failures. Non-yielding glasses and ceramics may be attractive because of their high strength-to-density ratio but because of their brittleness they can only be used if tensile bending stresses are entirely absent from vessels. Fiber reinforced plastics are similarly sensitive to sheer stresses. There is no substitute for alloys for exterior applications. The choice again lies between steels and titanium and aluminium alloys. The former are more attractive in design and fabrication and the latter from the point of view of lightness. Lighter alloys are to be chosen only if deeper depths are to be reached and steel alloys are likely to make vehicle too heavy for easy manoeuvres. hypothetical oceanspace vehicle is shown in Fig. 5. The simplest looking vehicle would, of course, be a spherical manned pressure capsulethe most efficient form for resisting pressures. For ease of movement, however, an elongated, cigar shaped body is preferable.

Conclusions

It becomes obvious that deep diving is as complicated as high speed, high altitude flying or orbital operations. Attaining depth or altitude is only a part of the problem—time on station, speed, range and payload are equally important.

A large number of factors need to

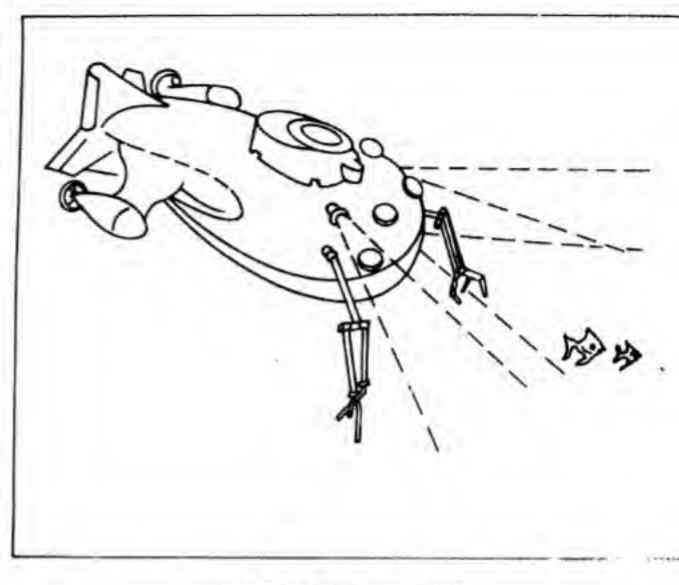


Fig. 5. An ocean space vehicle

be considered before a constructional material is selected. Reexamination of existing materials and techniques may lead to possible expansion of their use to new areas. If existing materials and techniques prove inadequate, new discoveries need be made in materials science and technology. All such developments are, however, planned only after an analysis of the properties which the material is required to possess.

Further reading

 Wile, G.J., Super alloys for aerospace applications, J. Metals, Sept. (1963), p. 645.

- Deutsch, G.C., Materials for supersonic transport, J. Meta March (1963), p. 185.
- Rittenhouse, J.B. and Singleta J.B., Materials for space static Metal Progress, Feb. (1966), p. 5
- Gatzek, L.E., Olsen, R.P., Kor L.J. and Clancy, H.M., Marials and fabricating methods f the Apollo spacecraft, Methods Progress, Feb. (1966), p. 64.
- Pellini, W.S., Materials f oceanspace, Metals Revie Aug. (1965), p. 5.
 - Modern Ceramics, John Wile and Sons Inc., N.Y. (1967).

LETTERS (Continued from page 513)

is prepared to classify nylon fabrics/ garments as petrochemicals?

Dr. S. Maiti seems to have diverted from a scientific discussion and run down the "bureaucratic systems". In defining a technical word mentioned in a statute, only the correct meaning holds good, however unpleasant it may be. The point that I have been trying to make is that synthetic polymers like resins, elastomers, fibres, plastics, etc., rightly belong to a special class of materials which are distinct from

that of "petrochemicals" from the technical as well as common point of view.

DR. V.S. RAMANATHA Chief Chemist, Central Revenue Control Laboratory, Hillside Roa I.A.R.I., P.O. New Delhi-1 Boolean algebra provides rules of combination operation of binary variables, and for every combination operation there is a corresponding electrical gate to implement the same and give the output in the digital form. A computer is essentially a system which mechanizes Boolean algebraic operations

ON COMPUTER DESIGN

R. RAMASWAMY

THE basic philosophy behind all digital computing systems is digital computing systems is that by using only the two digits I and 0, the binary codes, logical situations involving true false, and arithmetical situations involving addition. subtraction. multiplication and division can be handled and implemented by electrical switching circuits which have only two stable states, either on or off. Boolean algebra provides the rules of combination of the binary variables, and for every combination operation there is a corresponding electrical gate to implement the same and give the output in the digital form. A computer is thus essentially a system which mechanizes Boolean algebraic operations, using the binary digits or the binary bits I and O.

Principles of Boolean algebra

Boolean algebra starts with the simple logical assumption that if a thing is true it cannot be false and if a thing is false it canot be true. The true state corresponds to the binary code I and the false state

In mathematical language we can state the assumption known as the principle of duality as

A = 1, if A is not equal to 0. and A = 0, if A is not equal to 1. The deceptively simple principle as stated above is the basis of all Boolean operations.

Combination rules for Boolean operations

There are three types of combinations in Boolean algebra like the four types of combinations, +, -, × and in the conventional algebra. These are the AND, OR and NOT operations. The AND operation is represented by a × or a dot, or sometimes without any symbol in between. This operation is analogous to the multiplication operation in ordinary algebra. The rules of AND operation are:

$$A \times 0 = 0$$
 $A \times 1 = A$
and $A \times A = A$

where A is the binary variable which can take any one of the values, I and 0 Substituting the values of 1 and 0 in succession for the variable A we get the rules of the so called binar multiplication or logical product If A and B are the input binary variables and C is the output of the ANI operation, the result is represented if the truth table as given below:

Truth table for the AND operation

A	В	C
0	0	0
1	0	0
0	1	0
1	1	1

In logic we say that the statemen "I am mad and you are mad" is true only if both the propositions connected by AND are true. If any or or both the propositions are false, the entire AND combination is fals. This is reflected in the AND true table.

The OR operation usually represented by the + sign is analogous the addition operation in the convetional algebra with the following rules:

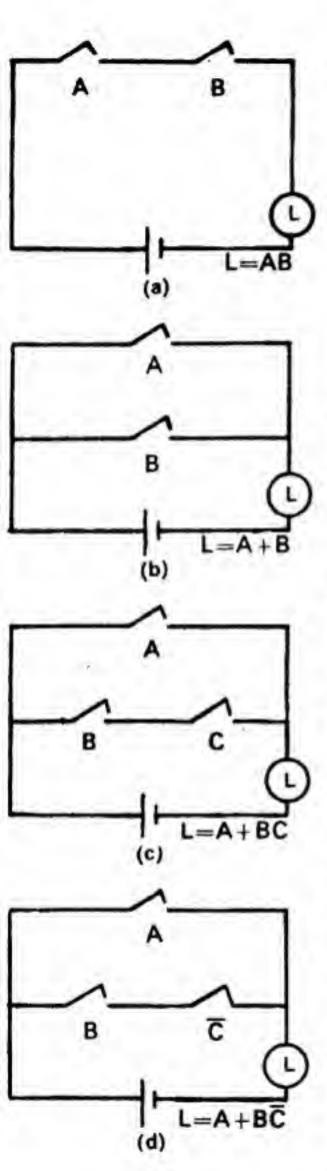


Fig. 1

ubstituting the values of 1 and 0 succession for the variable 1, we et the rules of the binary addition or

et the rules of the binary addition or ogical sum. If A and B are the input

binary variables and C is the output of the OR operation, the result is represented by the truth table as given below.

Truth table for the OR operation

1		B		C	7
0		0	T	0	-
-10		0		1	
0		1		1	- 13
1		1		1	
	1		100		

In logic we say that the statement, "Either you are mad or I am mad" is true if any one is mad or both are mad. The OR combination is true if any one of the combining propositions is true or both are true. This is reflected in the OR truth table.

The NOT operation is simply the statement of the logical principle, that if a thing is 1 it is not zero and vice versa. This postulate introduces the concept of inversion or complementation or negation and is indicated by putting a bar over the binary variable or the code. The rules of the NOT operation are:

This means that 1 and 0 are opposite states and that they become equal if either one of them is inverted. NOT is a uniary operator since it operates only on one variable. A is read as "NOT A"

Boolean functions

The equations connecting the Boolean variables can be called Boolean functions. For example, C = AB and C = A + B are Boolean functions, where A, B and C are Boolean variables which can take any one of the two values 1 and 0. Truth tables can always be formed for every Boolean function by substituting the values of 1 and 0 in succession to the different independent variables.

Physical implementation of logical operations in electrical circuits

An electrical circuit consists of one or more switches which can

exist in "on" or "off" states alon with the usual active and passiv components. The switches can be s arranged that their conditions "on or "off" produce a desired outpu For example, consider a lighting circuit with two switches A and as shown in the Fig. I(a). When the switches A and B are in the unac tuated state (say I state), there is n light output and we say L is i zero state. L can be brought to state only when both A and B ar actuated, i.e., both A and B ar brought to I state. The above switch ing circuit implements the Boolea operation, L=A AND B or th Boolean function Land B. The light L displays the result of the Boolea function L = AB. In a similar way switching circuits for different Boo lean functions can be designe and implemented. Fig. 1(b), 1(c and I(d) represent the switchin circuits of the Boolean functions L=A+B, L-A+BC and I=+BC respectively. For the sake of simplicity we have shown manua switches to implement Boolean func tions, but in actual computers the switching operations are done auto matically according to the input an the output in any desired form. It the example given above the outpu is given by the on or off states of the light. In actual computers the outpu may be in the form of punched card or magnetic tapes or printer forms.

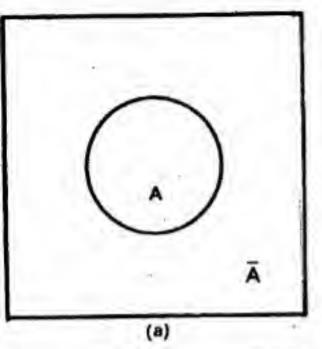
Rules of Boolean algebra

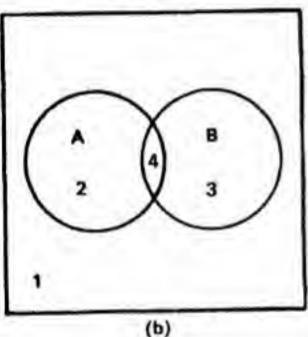
It is often necessary to transform Boolean functions into different forms for practical implementation. So it is necessary to know the rules of Boolean algebra. Some of the rules of Boolean algebra. Some of the rules of Boolean algebra are the same as of conventional algebra. For instance, the commutative law, the associative law and the distributive law are the same in both.

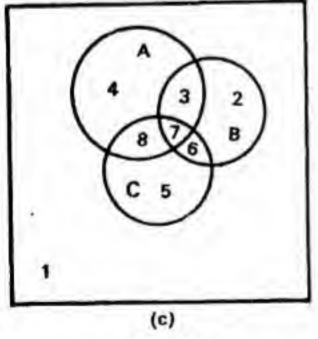
Commutative Law:

$$P+Q+R=R+Q+P$$

 $PQR=RQP$







Fle. 2

Associative Law:

$$P+Q+R= (P+Q)+R=P+(Q+R)$$

$$PQR=(PQ)R=P(QR)$$

Distributive Law:

the law requires the added term to be combined with or distributed to each symbol of the product. Thus, when P is added to QR, it becomes equiva-

lent to:

$$QR+P = (Q+P)(R+P)$$

Idempotent Law:

PP=P; P+P=P

This law is not available in conventional algebra.

De Morgan's theorem

An important theorem which is very useful in simplifying and rearranging the terms of a Boolean function is the De Morgan's theorem. This theorem allows sums to be changed to products and products to sums, as follows:

$$P+Q=PQ$$
 $PQ=P+Q$

Stated in words, we say that the inversion of a function of several terms is obtained by inverting the individual variables and changing the AND's to OR's and OR's to AND's. For example,

P=(Q.R)+(S+TU).VWis inverted by applying De Morgans' theorem as follows:

 $\overline{P} = (Q + R)CS(T + U) + (V + W)$ All these laws can be easily verified by substituting the values of 1 and 0 for the different variables.

Deriving the Boolean functions from the truth table

The logical relationship between the input and the output can be described by a truth table, i.e., a table of combination in which the output condition is listed for all possible combinations of input variables. Two binary variables have 2ª =4 possible combinations, 3 binary variables have 21=8 possible combinations, and so on. If some combinations are not permitted, they are omitted from the truth table reducing the number of rows accordingly. By inspection of the values in the table, the designer synthesizes an equation by combining the symbols as required by the particular function. Next attempt is made to simplify the expression by employing the rules of algebraic reduction so as to imple-

ment the function making the least demand on the costly hardware and the precious computer time. For example, Table I, gives four conditions for which 'f' is true and four other conditions for 'f' are false.

Table 1

A	В	C	f
0	0	1	1
0	1	0	1
0	1	1	1
1	1	0	1
0	0	0	0
1	0	0	0
1	0	1	0
1	1	1	0

The Boolean function can be derived from the Table 1.

The condition 'A false, B false and C true' is recognizable as a product. This statement implies that A is true, B is true and C is true and so the first condition for truth is ABC. The other terms are similar products. The complete description of the conditions of truth is, therefore, a sum of four products given by:

f = ABC + ABC + ABC + ABC

The above equation proves to be true for the sets of values given in the first four rows and false for the sets of values given in the last four rows of Table 1. When a function is written from a truth table, it can assume any of the two forms, namely, the



"The computer that you got fixed concealed from the workers' views has given out its weekly report. It say, er, that you came late three days talked to your wife on official telephone 5 days and compared you lottery results 4 days, er.."

... and now microcomputers

M ICROCOMPUTERS have arrived! These machines can now be available in the size of a cigar box. A single "chip" in it, which is less than a quarter of an inch on an edge, can incorporate well over components. It requires 20,000 power less than a few hundred milliwatts. Moreover, it is cheaper than the contemporary computers, yet as fast and powerful.

The advent of microcomputers is not a coincidence. It was a calculated reality. In view of the rapid advances made in microelectronics in the last decade, its arrival was merely a question of time. When microelectronics was born in 1960's, electronic industry began the work of integration of microscopic components. Component's density in a chip gradually increased and progress was made in circuit organisation, which all led to complex circuitry in computers but reduced their sizes and prices. It gave birth first to minicomputers, and now more compact and powerful microcomputersclaimed as the ultimate devices. The early microcomputers (Scientific American, May, 75) appeared in 1971; they were made of P-channel type (transistors operated by positive current carriers "holes") while the

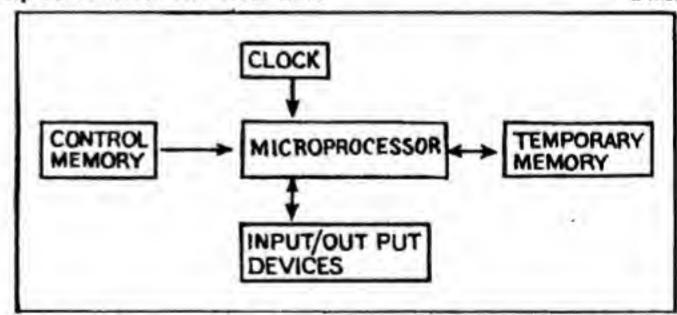
recent ones which made their appearance in late 1974 are bipolar type (currents in transistors are carried by both electrons and "holes"). The fatter ones are not only more powerful but also require less power and create no extraneous noise.

The "brain" of a microcomputer is microprocessor. In conjunction with three other devices (see figure): control memory, temporary memory and clock, it forms the computer. For instance, when a problem is microprogrammed, i.e., in its special languague the program is made, it is fed into the computer. First it goes to processor. If some data have to be used throughout the problem, they are stored in the memory for use when needed. In case, a datum is required only for a step or so where afterwards it be-

comes obsolescent, it is stored the temporary memory. The ca culations, logical operations an data-manipulations are all done b the processor, whose actions as synchronized by the electronic clock This process is nothing new to thos who know about computers. Th present price of Intellec-8 is \$3,540 However, it it estimated that the da is not far off when a microcompute will not cost more than \$50.

Microcomputers, because of the 'micro' size, lower cost and power would be put to use in various field other than research. Some likely use are in traffic-light controllers, ban terminals, telephone systems, busi ness machines, medical diagnostic in struments, educational programmes etc. It is envisaged that by 1980' it will be in use in household alsomonitoring electronic gadgets, secu rity devices and even toys!

D.M.S



minterm and the maxterm. If the function is expressed as a product of sums, it is called the maxterm and if the function is expressed as a sum of products, it is called minterm. A product is true only for one of all the possible combinations. Thus a product is more restrictive, with the minimum number of true combinations of any type of form. A sum is least restrictive because it is true for all except one combination, the maximum number obtained with any form. When the function is to be expressed in the maxterm form, the products of the

sums of terms for which 'f' is false are taken, since De Morgan's theorem tells that the sum is true (with each proposition primed) when the product is false. The maxterm form obtained from the Truth Table 1 is given by

f = (A + B + C)(A + B + C)(A + B + C)(A+B+C)

The above equation can be verified to give the correct value of 'f' for all the 8 sets of values of A, B and C given in Table 1. Any of the two forms can be selected for practical implementation depending on their relative advantages.

Minimization of logical functions

A logical function translated from a truth table is said to be in the canonical form and a circuit buil according to the canonical form of the Boolean function may use more parts than necessary for effecting a certain computation. So it becomes necessary to simplify the function to provide an economic hardware solution. Certain procedures are prescribed for reducing the switching equations to some minimal form (in the sease that there is no unique minimum). For example, the function iven in the last example can be implified as follows:

$$f = \overline{AC}(\overline{B} + B) + BC(\overline{A} + A)$$

= $\overline{AC} + B\overline{C}$

Thus, four terms containing three factors are reduced to two terms of only two factors. This form is called a minimal form because it contains the fewest terms and factors. In this case there is no symbol common to both terms. So, it is clear that no further reduction is possible.

There are three main criteria which may be used to determine a minimal sum of products (or products of sums) expressions.

 The expression must have the fewest literals. A literal is defined as either a complemented or an uncomplemented binary variable.

2. The expression must have the fewest terms, and

 The expression must demand the least number of logical blocks or units in its circuit implementation.

The last criterion is the one which is important in practice, since it affects the economics of the project. This means that the characteristics of the logic modules such as type of logic function, number of inputs, speed of operation, etc., must be taken into account and used as constraints upon the design procedure. For example, consider the minimal switching equation:

Direct implementation would require 5 input AND gates and 4 input OR gates with an overall total of five basic modules. But suppose the logic modules to be used are 3 input AND 3 input OR gates, the equations have to be factorized as

$$Z = AC(BDE + BD) + AD(BC + BCE)$$

This function uses a total of nine basic modules and involves many more inter-connections. Because of more stages, switching delays through the circuit (propagation delays) will be greater, which will adversely affect the

speed of operation. Thus, the reduction of switching equation to a form containing the least number of literals and terms is not the complete answer to logical circuit design and the equation is to be manipulated further to realize an optimum design in terms of actual hardware.

Graphical methods of minimization of logical functions

Apart from the algebraic methods of reduction of logical functions, graphical methods using Venn diagrams and Karnaugh maps have been found useful in several cases. The pictorial appeal is also more effective.

Venn diagram. We know that every logical situation can be described by either true or false or in the binary codes by 1 or 0. Such a situation can be pictorially represented by marking an area within a circle to represent a quantity A and the remaining area within a bigger square to represent A as shown in the Fig. 2(a). The total of A and A is taken to represent 1. A and A represent logically compatible quantities. For example, if I represents people, A can represent men and A can represent women. (A or A cannot be donkeys). Venn diagram for one variable is shown in Fig. 2(a). Fig. 2(b) represents the Venn diagram for two variables A and B. The two circles a and b divide the area within the square into four parts. The areas 1, 2, 3 and 4 can be identified as AB, AB, AB and AB respectively. Fig. 2(c) represents the Venn diagram for three variables A. B and C. The circles a, b and c divide the square into 8 distinct areas 1, 2, 3, 4, 5, 6, 7 and 8 representing ABC, ABC, ABC, ABC, ABC, ABC ABC and ABC respectively. Many simplifications can be made using the Venn diagrams. For example, the sum AB+AB becomes equal to the area A in Fig. 2(b). In a similar way we can find the sum or product of several combinations by studying the Venn diagrams. The sum is obtained by adding the areas which may or may

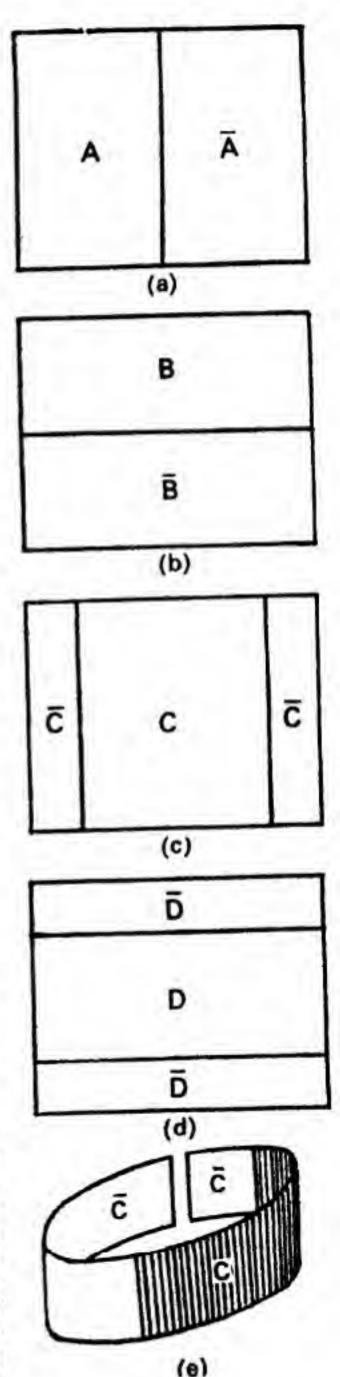
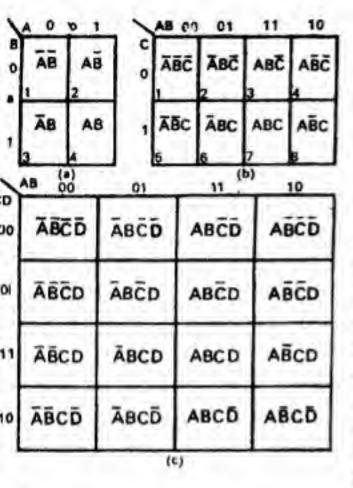


Fig. 3



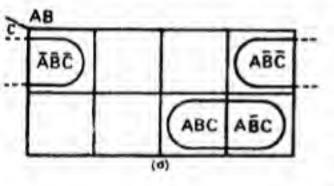


Fig. 4

ot overlap and the product is obained by finding the area which is ommon to all the entities. The proluct is highly restrictive and the value s always smaller than the smallest f the entities involved. Once the reas are carefully drawn to make ertain that areas are properly overapped or separated, many relationhips become obvious. It becomes onfusing to draw Venn diagrams for nore than three variables since it ecomes difficult to observe which ombinations are equal to others. arnaugh maps overcome this diffiulty to some extent.

Karnaugh maps. The Karnaugh map is a way of representing Venn liagrams with a subdivided square and maintain the labels used for the circles. For a one variable map, A and A are represented by vertical dividing line across the middle of the square as shown in fig. 3(a). For the second variable, and B are represented by a hori-

zontal dividing line in the middle of the square as shown in Fig. 3(b). For the third variable, C and C are represented by drawing two vertical lines as shown in Fig. 3(c). For the fourth variable, D and D are represented by drawing two horizontal lines as shown in Fig. 3(d). In Fig. 3(c) and 3(d) the areas C and C and D and D seem to be discontinuous. The area representing one variable must not be discontinuous, lest it may be mistaken for another variable. If we fold Fig. 3(c) into a cylinder about a vertical axis as shown in the Fig. 3(e), we find that the surface area of the cylinder is divided into two different continuous areas C and C. In a similar way Fig. 3(d) can be folded so as to make a toroid thereby making the area D continuous. The K map for two variables A and B is shown in Fig. 4(a). The lines a and b divide the square into 4 parts 1, 2, 3 and 4 as in the case of Venn diagram Fig. 2(b), each part representing the products AB, AB, AB and AB respectively. The three variable and the four variable K maps are shown in Fig. 4(b) and 4(c) respectively. The four variable map is the most popular one which is used for manipulating either two or three or four variable Boolean functions. For example, to find the area ABC in a four variable K map, simply add the areas of ABCD and ABCD. Of course, the two four variable terms must be adjacent in order to make the addition and it is not difficult to make the choice for eliminating one variable which is not required. Similarly, a two variable term can be obtained as the sum of two three variable terms and so on. Having represented the different areas in the K maps, how a function can be demapped may also be seen, that is, coalesced into a simpler minimal function. In a three variable map a single square is described by three letters. Adjacent squares in the K map differ only in

one value. When two adjaces squares are added, the combined at can be represented by two letters (or less) and the letter that is omitted the one which changes value in two adjacent squares. Suppose, it required to minimize the function.

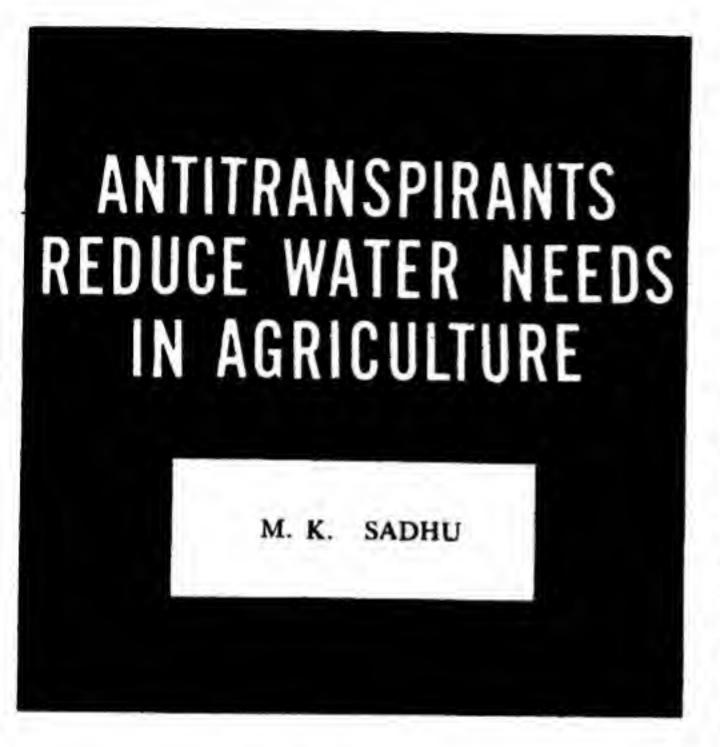
The squares belonging to the different terms are marked first. Then t squares which have no neighbou are noted. They are accounted for themselves and are not amenable f further simplification. Look for t squares which have only one neigh bour. Combine their areas. Then los for the squares which have two neig bours and combine their areas. S whether there are squares which ha an "end around" adjacency. If, s combine these squares. In Fig. 4(the squares belonging to the terms the above function are marked. The squares ABC and ABC are adjace and they are added to give AC. To squares ABC and ABC have "en around" adjacency. They are the added to give BC. Since there are r further adjacencies, no further r duction is possible and the minim function is given by:

$$f = AC + BC$$

With practice, a designer will become proficient in employing these may for finding the minimal function which will yield an economic hard ware solution for actual implementation. Only the basic approach to computer design is presented in the article and it is hoped that these idea will give the necessary background for further studies.

Further reading

- 1. Rose, Alan, Computer Logic Wiley Interscience, London, 197
- Rbuyne, V. Thomas, Fundamentals of Digital Systems Design Prentice Hall, New Jersey, 1973
- Ligomenides, P.A., Information Processing Machines, Holt, Rine hart Winston, N.Y., 1969.





There are now experiment evidences that plant transpiration can be reduced by artificine means. By cutting down transpiration plants lose nothing but farmers gain

DLANTS are so made that the lose a tremendous amount of water mainly by transpiration a water vapour through the stomate or stomata. Excessive water los however, causes severe wilting wit adverse effects on growth and flower ing of plants. It has been found tha only less than one per cent of water absorbed by plant roots is retained within the plant and considerabl smaller percentage is contained in the harvested crop. Wheat plant transpire 3000 litre of water for th production of I kg of grain. It ha been estimated that about two-third of the rainfall is wasted in this way and the loss may be as much a 40,450 litres of water per day from one hectare of corn.

Although the role of transpiration in several physiological functions o the plant has been much debated, it is clear from various experimenta evidences that there is a good deal of scope for controlling and reducing the transpiration rate by artificial means without any adverse effect on plants but with distinct advantages to the grower. Therefore, the possibility of reducing transpiration-thus saving water and also alleviating the adverse effects of water imbalance on plant growth when transpiration exceeds water absorption-presents a unique field in agricultural research in India, especially when scant rainfall has become frequent in recent years. The introduction of high yielding crop varieties which require plenty of water for their normal performance further emphasizes the need for research in this line, because at

Dr. Sadhu teaches at College of Agri., Univ. of Calcutta, Calcutta

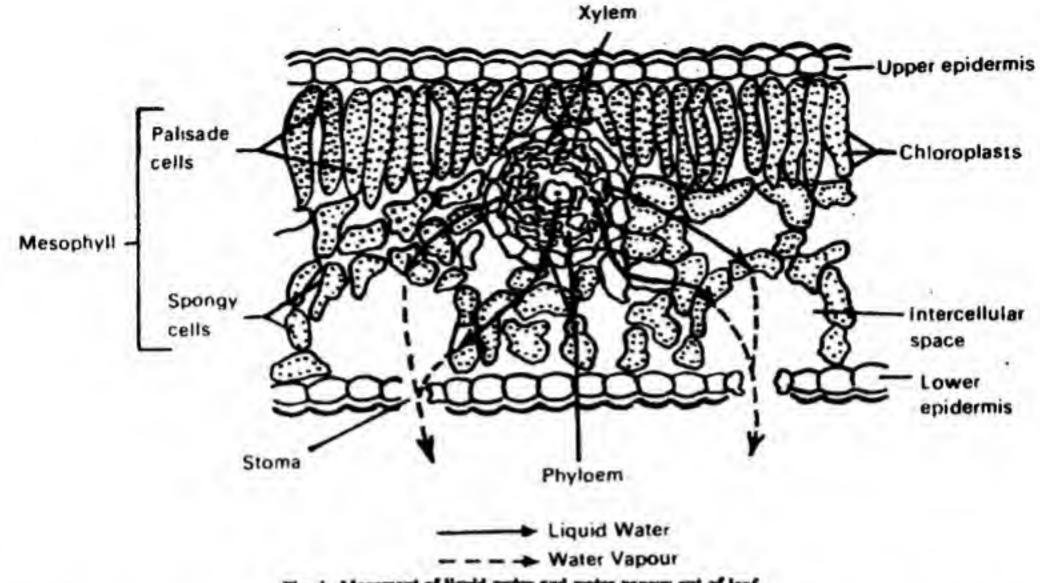


Fig. 1. Movement of liquid water and water vapour out of leaf

resent the cultivation of high yielding acieties is limited to areas with dequate irrigation facilities and high ainfall. Most of our farmers do not are to cultivate these varieties for his obvious reason.

Before discussing the different spects of reduced transpiration, let s see how the stomata control ranspirational water loss in nature.

tomatal control of transpiration

Stomatal transpiration occurs in wo stages: (i) evaporation of water rom the wet mesophyll and chlorenhyma cells into intercellular spaces f the leaf, and (ii) diffusion of water apour from the intercellular spaces nto the outside air (Fig. 1). Such iffusion of water vapour takes place when the stomata remain open.

In general, the stomata themselves how a diurnal periodicity, closing t night and opening during the day. That this periodicity is related to ght can be easily demonstrated by eeping the plants under darkness which leads to stomatal closure. Of ourse, there are many exceptions to his general phenomenon. In order to applain such periodicity, the mechanical contents and the stomatal closure.

nism of stomatal movement should be first understood.

Each stoma (singular) consists of two epidermal cells known as guard cells (Fig. 2). The walls of the two guard cells of a stoma are not evenly thickened. In a typical guard cell found in most species of plants, the cell wall is thicker on the side bordering the stomatal pore than on the side bordering the epidermal cells (Fig. 2). With the increased absorption of water by the guard cells (increased turgor), the thinner walls of the guard cells are stretched more than the thicker, thus producing a bulge in the thinner outer wall and a consequent pulling apart of the thicker inner walls bordering the aperture. Decreased water content leads to closure by the spring-like recoil of the thicker inner walls. Since the stomatal movement is controlled by the water exchange, any factor that alters the water content of the guard cells will affect their turgor and, therefore, the stomatal opening. Moreover, stomatal opening is possible only if the guard cells can push back the epidermal cells adjacent to them. These epidermal cells, as long as they remain

turgid, exert a back pressure on the guard cells. If all the epidermal cell increase equally in osmotic potential and turgor pressure, no stomate opening would result. Therefore, on can generalize that in all cases of stomatal opening Ptg = Pte, when

Pte=turgor pressure of guard cel Pte=turgor pressure of surround ing epidermal cells

The opening and closing of stomata controlled solely by water movement into or out of the guard cells. The water movement, in turn, is controlled by light through its action of cell solute content. The overall effect of light and darkness on stomate opening and closure, as suggested by G.W. Scrath of McGill University Montreal (Canada) in 1932, has been shown in Fig. 3.

Reduced transpiration and physical functions

Opinions on the significance of transpiration range from holding that it is essential for such processes a leaf cooling, mineral uptake and transport, to the belief that it is ntirely unnecessary and merely an nevitable consequence of plant tructure.

ranspiration and leaf temperature

Except in conditions of high isoation and relatively high humidity, lant leaf temperatures are very lose to ambient air temperature. field measurements with a number of lifferent plant species reveal that with slight wind of 50 cm Sec-1(10 cm ec-1 being equivalent to conditions f essentially no wind or free conection) and with leaves of moderate ize, a relatively large reduction of ranspiration (40%) raises the leaf emperature to 2°C-2.5°C only. uthermore, in many plants stomata end to close during the hottest hours f the day, when cooling by transpiation would be most beneficial. It ppears, therefore, that only under xtreme conditions of high incident adiation and very low wind velocity. eaf temperature would be signifiantly raised by reduced transpiraion.

Transpiration and ion uptake and ransport

The possible effect of the transpiraional stream on the uptake and ransport of minerals has been much debated in recent years. There appears to be some effect of transpiration rate on ion uptake, but this varies according to the type of the plant and the specific ion involved. There is essenially no proportionality between mineral uptake and transpiration rates.

From experimental evidences, it can be safely concluded that normally transpiration can be halved without any detrimental effect on the plant, except under most extreme conditions. On the other hand, under conditions of excessive transpiration, reduction of the rate of transpiration would prevent the development of water deficit.

Reduction of transpiration

The first requirement of any method

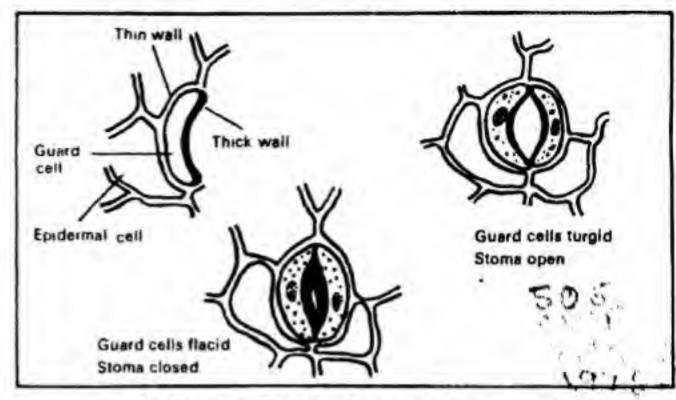


Fig. 2. Diagrammatic scheme of turgor curvature of a guard cell

for reducing transpiration is that it should not interfere with the plant growth. The reduction of plant transpiration is not in itself difficult to accomplish, but to do so without interfering with photosynthesis and growth is the central problem of antitranspirant (materials which reduce transpiration) studies.

Recently, a number of methods have been studied as possibilities for reducing transpiration. The four most important ones are; (a) increasing leaf reflectance which reduces net energy uptake, (b) windbreak, which increases the air resistance to water vapour transfer, (c) enclosures in which the air humidity builds up, thus decreasing the leaf-to-air vapour density gradient, and (d) applying metabolically active materials which tend to close the stomata, or alternatively, coating the leaf surface with an inert film.

Modification of leaf reflection

Not much work has been done on the use of reflective materials as antitranspirants. Sixty per cent of the solar radiation is of wavelength longer than 700 nm and is not used in photosynthesis, which, however, considerably increases the leaf temperature. Attempts are now being initiated to develop a material which ideally and selectively would reflect all radiation below 400 nm and above 700 nm and would transmit the radiation in between.

The material must be non-toxic stick and spread evenly on the leasurface, be stable and sufficiently permeable to gases so as not to interfere with photosynthesis and respiration. The leaf temperature should no drop below air temperature.

Application of white wash spray to walnut trees reduced the lea temperature and increased the size of nuts. Spraying the leaves of different plant species with kaolinite reduces leaf temperature by 3°C 4°C and transpiration by 22-28 per cent. This is ascribed to increased lead reflectivity.

Windbrenks

Windbreaks will be of value in reducing transpiration mainly in



"Of course, my anti-transpirul will reduce water needs of plant but the only snag is that a considerable quantity of water would be require for its dilution before use."

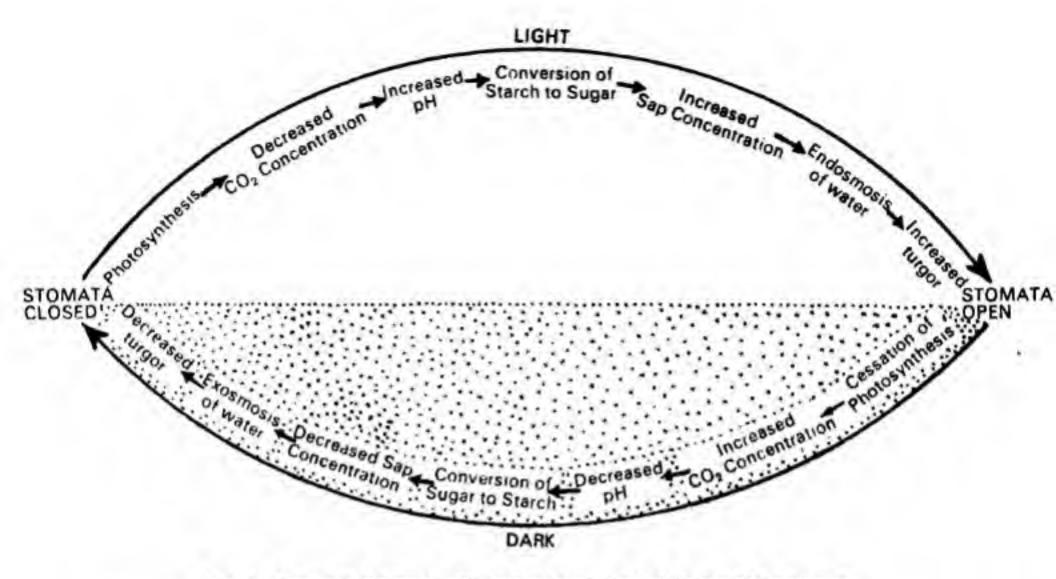


Fig. 3. Changes in the guard cells leading to opening and closing of the stomata

desert climates by lowering the wind speed. The particular climate, crop and economic situation will determine whether windbreak is worthwhile and which type is more appropriate. However, the problems are; (a) uneconomy in most cases, (b) long time required for establishment of live windbreaks (trees, hedges, tall grasses, etc.), and (c) high cost of setting up and maintaining inert fences.

Enclosures such as plastic green houses are theoretically very attractive in sunny climate for attaining more efficient use of water, by maintaining high humidity in the air around the plant and thereby reducing transpiration. Besides, maintenance of high carbon dioxide concentration increases the rate of photosynthesis under a condition of intense sunlight. Moreover, high conentration of carbon dioxide tends to close the stomata and reduces transpiration. But heavy capital investnent and high maintenance cost are required. Besides difficulty in dissipation of unrequired heat, more ncidences of disease in the hot and wet atmosphere are observed.

The leaf resistance to transpiration can be increased by covering the leaf with inert film forming substances and/or by spraying chemicals that induce either complete or partial closure of stomata.

Film forming antitranspirants

Coating the leaves with an inert material to prevent water loss is the oldest recorded method of reducing transpiration (Theophrastus, 300 B.C.). This group of compounds includes waxes, wax-oil emulsions, higher alcohols, silicones, plastics, latexes and resins. Besides conserving water in plants, film forming antitranspirants may also yield other benefits from their protection layer by reducing damage from insect pests, fungi, smog, salt spray and undesirable water uptake by fruits from rains or sprinklers. Further, these materials may be used as slow release agents for mineral nutrients (such as iron and zinc which are often supplied as foliar application) and also for insecticides and fungicides.

The main practical problem with

antitranspirants of the film formi type is to obtain a material whi would form a very thin, continuou flexible and durable film on the le surface and at the same time wou be nontoxic and stable under inten ultraviolet radiation of the sunligh At the thickness obtaining on t leaf (about 0.1-14), the film shou be essentially impermeable to wat vapour and sufficiently permeable carbon dioxide so as not to great impair photosynthesis. Present available materials have all the abo characteristics except permeability carbon dioxide. This is because the solubilities and coefficient of diff sion of gases and vapours in pol thene films are inversely proportion to their molecular weight and dime sions. The water molecule is, ther fore, basically more mobile than th of carbon dioxide. Secondly, becauof the presence of wax and hair of the leaf surfaces of many plant complete coverage of the foliage wit an antitranspirant is seldom possible Thirdly, plants constantly producing new leaves in the growing seaso require frequent application of an ranspirants. Finally, the cost of the naterials and its application must be ess then the value of water saved nd/or the increased crop yield.

laterials causing stomatal closure

It has long been observed that nany spray materials commonly pplied to plants close stomata and reuce transpiration. Such effects have een reported for herbicides, fungiides, metabolic inhibitors and growth ormones. Unfortunately, materials vailable to date do not act specifially on the stomata. Phenylmercuric cid which has been widely used in nducing stomatal closure in a numer of plants is not acceptable for pplication to edible crops because of oxic mercury ions. Moreover, phenylnercuric acid is a known inhibitor f phosphorylation and hence would amage the foliage by blocking hotosynthesis. An ideal stomata losing type antitranspirant should ave the following characteristics:

- (i) non-toxicity, so that it can be applied to food crops;
- (ii) the stomatal mechanism should not be permanently damaged;
- (iii) specific action on the stomatal guard cells, with little or no effect on other cells of the leaf;
- (iv) the effects should be persistent over one or more weeks; and
- (v) it should be cheap and easily available.

Recently, abscisic acid has been uggested as a non-toxic naturally ccurring stomata closing agent which can be used as an effec-

tive antitranspirant. Nevertheless, more research in this respect is necessary.

Possible uses of antitranspirants in agriculture

There are almost limitless possible uses of antitranspirants in agriculture.

Field crops. Antitranspirants will help in growing high yielding crops with high water requirements in areas which tend to be too dry for all or part of the year.

Transplantation of fruit plants. Trees which are uprooted and moved with bare roots or even with a rootball of soil, undergo severe physiological shock. As many small absorbing roots are lost and the previously well established contact of the whole root system to the soil is destroyed, their capacity for water absorption is greatly diminished while transpiration continues. The decreased absorbing capacity of the root systems of transplants can be compensated for by decreasing the rate of transpiration through the use of antitranspirants.

Fruit cracking. Rainfall during the later stages of ripening of fruits like cherry, grapefruit, banana, tomato causes the fruit to crack, resulting in great loss of the crop. Laboratory tests have shown that water absorption of fruit which causes cracking can be greatly reduced by an antitranspirant spray.

Ornamental horticulture. Preliminary field trials and pot studies with ornamental plants showed that a film forming antitranspirant can reduce transpiration by 35 per cent and can delay irrigation by two to three weeks.

Antitranspirants can also be used on lawns and house plants so that they will not require watering while the house owner is away. There is also much scope of using these chemicals in cut flowers which lose turgidity within a short period, because transpiration generally exceeds absorption.

Not much work has been done in India on this aspect, although we have before us a very exciting field of research to study the significance of reduced transpiration in modern agriculture.

Further reading

- Davenport, D.C. (1967), Effect of chemical antitranspirants of transpiration and growth of grasses, J. Expt. Bot., 18, Pp. 332-347.
- Davenport, D.C. and Hager R.M. (1970), Antitranspirants McGraw-Hill Yearbook of Science and Technology, Pp. 113-251.
- Gale, J. and Hagen, R.M. (1966)
 Plant antitranspirants, Ann. Rev Pl. Physiol., 77: Pp. 269-282.
- Zelitch, I. (1965), Environmental and biochemical control of stomatal movement in leaves, Biochem., 40, Pp. 463-482.
- Zelitch, I. (1969), Stomatal Control, Ann. Rev. Pl. Physiol., 20 Pp. 329-350.

ATTENTION SUBSCRIBERS

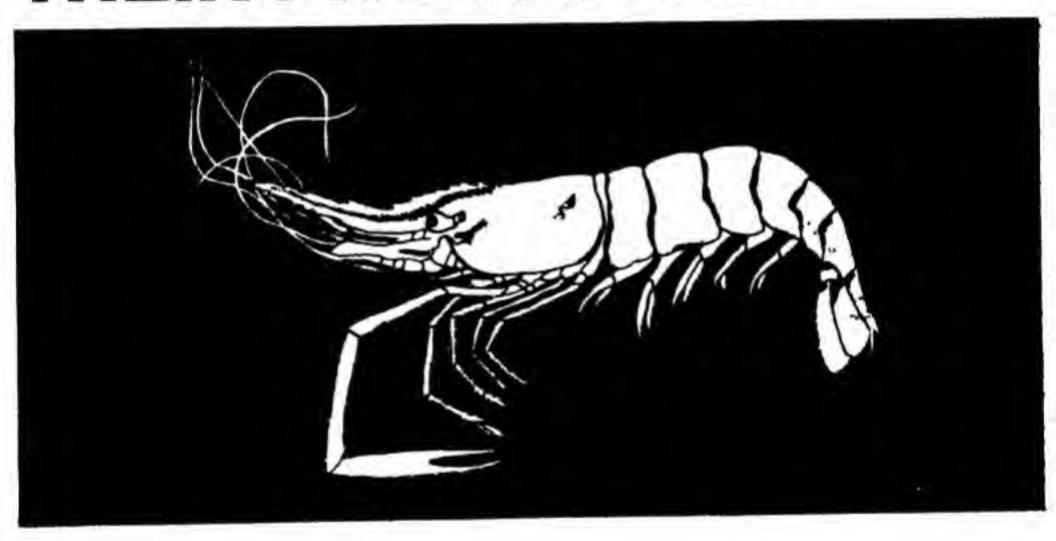
On page 469 in S.R. of October 1975, subscription rate has been wrongly printed as Rs. 5/-. It is Rs. 10/- for 12 issues. Please renew your subscription by remitting Rs. 10/- by M.O. or P.O. to the Chief (Admn.), CSIR, Rafi Marg, New Delhi-110001.

Please do not forget to mention your subscription number while remitting the amount.

Editor

PRAVNS:

HOW TO INCREASE THEIR PRODUCTION



USHA GOSWAMI

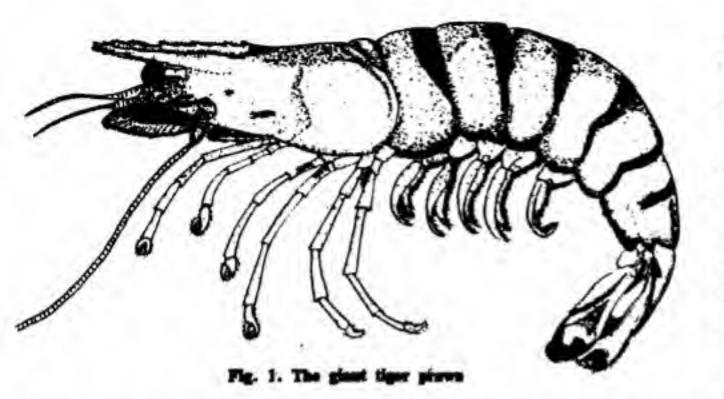
PRAWNS have through ages remained one of the cherished delicacies of the gourmet all over the world. The demand for them is increasing. India has great prawn potentials, but its yield is falling. What can be done to increase prawn production in India?

The prawns, commercially known as shrimps, are called Jinga, Kolambi, Sungata, Chemeen, Shetli, etc., in different parts of our country. They are either fresh water, brackish water or marine animals. Being nutritious and delicious (especially the larger

forms) they are valued as human food. Rearing of shrimps or prawns in captivity, popularly known as prawn farming, has been practised in India and other Asian countries for many decades. The methods used are, however, very crude and not much attention has been given to increase their yield. The existing prawn fishery in our country is based on natural resources and ranks second amongst

the prawn producing countries of the world. The shrimps comprise an important item of our export trade earning over 75 crores of rupees a year in foreign exchange. The regular increase and technological improvements in our processed prawn products have greatly enhanced their global demand. However, in the last few years, a sudden decrease in the prawn yield has caused a serious

The yield of prawns—the cherished delicacy—is decreasing. The only way to increase their yield is through scientific farming



concern amongst the exporters, entrepreneurs and fishery scientists. The cause of low production is the increased number of trawlers in the last few years allowed to exploit natural resources to the maximum extent. An important way to increase prawn production now is prawn farming.

There are many species of prawns distributed in both temperate and tropical waters and are suitable for culture operations. Many of these species are adapted to changing environmental factors like salinity, temperatre, dissolved oxygen, etc. Under controlled conditions, therefore, the success of culture would depend upon how a suitable environment can be created. A group of prawns known as the penaeids is much preferred for the culture work all over the world. Species like Kuruma prawn, brown shrimp, white shrimp, pink shrimp and Penaeus orientalis are being cultured in Japan, U.S.A. and South Korea. Similarly, "the giant tiger prawn" or "Sugpo prawn", Penaeus monodon; "Indian prawn", Penaeus indicus; "banana prawn", Penaeus merguiensis; "green tiger prawn", Penaeus semisulcatus and yellow prawns, Metapenaeus dobsoni, Metapenaeus monoceros and Metapenaeus affinis are well-suited to culture in tropical waters like those found in India, Pakistan, Bangladesh, Taiwan, Philippines, Indonesia, Malaysia, Singapore, etc.

In India, "the giant tiger prawn"
Fig. 1, "Indian prawn" and some of
the yellow prawns form the main brackish water species, whereas "the giant
fresh water prawn", Macrobrachium
rosenberghi and a smaller species
Macrobrachium malcomsoni found in
fresh water habitat are most suitable
for culture and should be utilized on
a commercial scale.

Almost all the species of the prawns noted above, except the fresh water forms, spawn in the sea. The larval stages have restricted powers of locomotion. They drift along with the currents of water and enter the estuarine and shallow coastal waters. They undergo changes resulting in postlarval forms and setttle at the bottom where they feed and grow further till they reach the juvenile stages. These young prawns are called post larvae. The late larval stages subsist on microscopic plants/organisms. Later, they feed on small benthic organisms and the decaying matter produced as a result of dead plants and animals (detritus). On reaching the juvenile stages, they enter the sea for breeding.

The giant fresh water prawn spawns in brackish waters and its post-larval development occurs in fresh water. The other species Macrobrachium malcomsoni, which constitutes about 98% of the riverine shrimp catches in India, breeds in fresh water. Its larvae drift towards estuaries, and after attaining the post-larval stage

they migrate to fresh water where they grow as adults.

Methods of culture

There are two different methods of culture. In the first method, prawns are allowed to breed in nature and their young ones from a particular stage onwards are collected for rearing. This method is very old and is called the traditional method of prawn farming. In the second method, all the life stages, from egg to adult, are propagated under controlled conditions. This method is quite recent and is known as intensive prawn culture. It was first developed in Japan.

The traditional method includes simple trapping, holding and growing of prawns, depending entirely on natural stocking of the post-larval stages. For this purpose, the ponds are selected in suitable estuarine and brackish water areas, where the tidal flow, soil, depth and salinity of water are suitable. These ponds are connected with the outer main tidal stream by sluice gates. When incoming tides in front of the gate reach a height of 60 cm above the pond level the gate is opened and shrimps are allowed to enter the pond. At dead tidal height, a 13 cm mesh screen is placed across the gate to retain the young shrimps. These are allowed to grow in ponds and are harvested at dusk or night during the full and new moon periods at the ebb tides, as the growing prawns try to return to the sea. Harvesting is carried out mainly by draining the ponds and accumulating the shrimps in small pans near the sluice gates or in the bag nets fixed in position just behind the gates. A more frequently used method is to place bamboo traps. Lights are often used to attract shrimps into the traps at night. In India and many south-east Asian countries, paddy fields are also utilized for prawn culture after paddy has been harvested. The larvae are allowed to feed on natural diet.

is slightly modified by altering the constrution of ponds and providing supplementary foods to the larvae (Pig. 2). Before stocking, the ponds are filled with tidal water upto 3 cm to 10 cm in depth to induce growth of microbenthos complex (email microscopic bottom dwelling organisms) locally known as 'lab-lab' which serve as food for the young shrimps. Stocking of post larvae is controlled, i.e., the young ones of a selected species 'Sugpo prawn' are introduced in the nursery ponds. These small ponds are located inside the main production pond and are separated by dikes. When the larvae grow in size, the dikes are opened and they are allowed to enter the mein production pond. In the nursery ponds, growth of floating, green filamentous algae which serve as food is discouraged, because the young prawns often get entangled in it. However, they are allowed to grow along on 'lab-lab' in the outer ponds. This food material is supplemented with rice bran or dead fish, which are placed in the corners of the pond. They also serve as fertilizer to the ponds.

The method followed in Philippines

Japanese method of Kuruma shrimp culture

It was in 1934 that Dr Fujinaga first achieved success in spawning and partial rearing of the Kuruma prawn. He perfected his techniques and in 1959 started the first pilot hatchery and farm. The numerous technological improvements introduced thereafter have made the Japanese method of prawn culture such a success that besides meeting the need of their own population, they rear and release the young ones in their inland seas to augment their natural shrimp fishery.

Gravid females are released in concrete tanks (30-50 females/57m³ tank, 50-100 females/200m³ tank) with regular temperature and aeration control. After spawning, the prawns

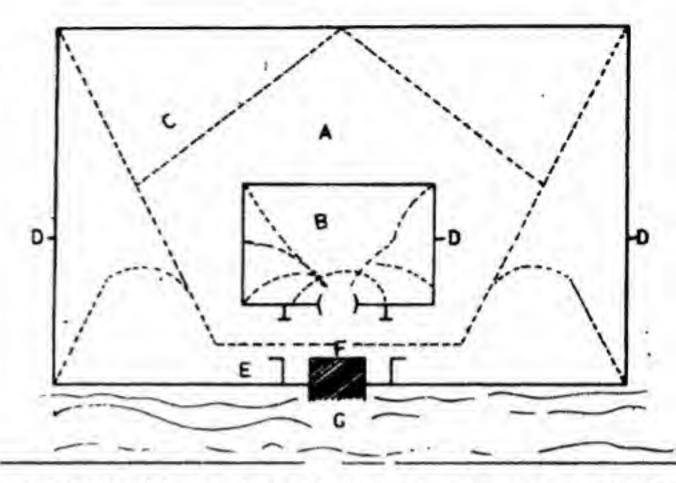


Fig. 2. Philippine shrimp pend: A-production pend; B-survery pand; C-dealing ditches; D-dike; E-catch pend; F-sluice gates; G-tidal stream

are removed from the tanks to prevent eggs from being destroyed. In early larval stages they are fed on small microscopic-algae (diatoms). When the larvae enter the post-larvae stage and settle to the bottom, the dissolved oxygen is maintained at the optimum level by regularly circulating and aerating the water. The young ones at this stage feed on small brine shrimp larvae, minced fish, bivalve meat and some worms, etc. The young prawns are now transported to the production ponds which are connected with the main stream through two pipes for the inflow and outflow of water. The pipes are fitted with fine mesh screens to keep the shrimps inside and the unwanted organisms out. The pipes are fixed to hydraulic pumps so that the flow of water is maintained. This method yields 2000 kg/ha to 6000 kg/ha of prawns to the Japanese shrimp growers.

Experimental culture in various countries

Many countries in the world are trying to achieve success in commercial shrimp culture following Japanese methods. However, to date the culture is mostly on an experimental scale. The United States of

America has succeeded in the cultur of brown shrimp, pink shrimp, while shrimp and the giant fresh water prawn. A commercial pilot cultur operation in Oahu, Hawaii, under th supervision of the States Depar ment of Fish and Game, produce 3000 kg/ha fresh water giant prawi Taiwan is achieving considerab success in shrimp culture. Formerly stocking of the giant tiger prawn an the yellow prawn was done from th natural resources. But during the la two years they have propagated s species in captivity from egg to the adult stage.

In India, the traditional method still widely practised and the intensiv culture method is on an experimenta scale. The area available for the purpose has been estimated a more than one million hectare With a long coastline of about 500 km and large areas of fresh and sa waters, a high potential for th production of shrimp on a con mercial scale can be envisaged. Th time is not far off when our scientis will be rearing all the importaspecies from egg to the adult stag The future of shrimp culture in Ind is bright.

(Continued on page 56



Heart lung machines carry ou functions of heart and lung during open heart surgery b maintaining the circulation of oxygenated blood through the body

iseases desperate grown
desperate appliances are relieved
not at all - Hamlet

Their name implies: they carry at the functions of the heart and the ing during open heart surgery by aintaining the circulation of oxynated blood through the body. Fore describing the heart lung achine, we will mention briefly bout the blood that the machine called upon to circulate, and the eart and the lungs of an adult aman whose functions the machine sumes temporarily. Detailed desciption of these would call for a parate article for each one.

ood

There are about 5 litres of blood the body. It contains approxitately 55% plasma and 45% red and cells alongwith small every sential but amounts of white blood lls and platelets. Red blood cells we hemoglobin, each molecule of hich carries four molecules of oxyn. White blood cells help in fighting fections. Platelets help in the for ation of a clot whenever a blood

vessel gets ruptured. The clotting mechanism is triggered by a protein, fibrinogen and other enzymes present in the plasma. When fibrinogen is removed from plasma, what remains is called serum. Plasma also carries a number of other proteins (about 6.5 gm/100 ml plasma). The detailed composition of plasma can be noted from any book on human physiology.

Heart

The heart contains four chambers called right atrium (RA), right ventricle (RV), left atrium (LA) and left ventricle (LV) as shown in Fig. 1. A muscular wall called septum divides the right and left sides with no direct connection between the two after birth. These two sides act as two positive-displacement pumps placed anterioposteriorly. Here, instead the contraction of a piston, of the ventricle results in pumping of the blood. The blood enters the right atrium through the superior and the inferior vena cava. From there it goes to the right ventricle through the tricuspid valve. The right ventricle pumps the blood through the semilunar valve and the

pulmonary artery to the lung (pulmonary circulation). In the lungs the CO,O, exchange takes place The oxygenated blood comes to th left atrium via the pulmonary vei and then enters the left ventricl through the bicuspid (mitral) valve When the left ventricle contract (heart beat) the blood is pumper through the semilunar valve into th aorta (systemic circulation). The flox in the aorta is pulsatile and th maximum pressure is about 120 mm of Hg. The aorta divides into arteries, arterioles and finally into small diameter capillaries (about 10 # where the blood gives out nutrient and part of its O, in exchange fo CO, and the unwanted end product of metabolism in various tissues. The capillaries merge into venules which combine to form veins and finall vena cava. The latter leads the bloo back into the right atrium completing one round of bloocirculation. The circulation rate about 5 liter/minute and there is a average of about 70 heart beats pe minute. Thus an average of abou 70 ml blood is pumped by each hear beat. The total circulation tim for the blood is about one minute.

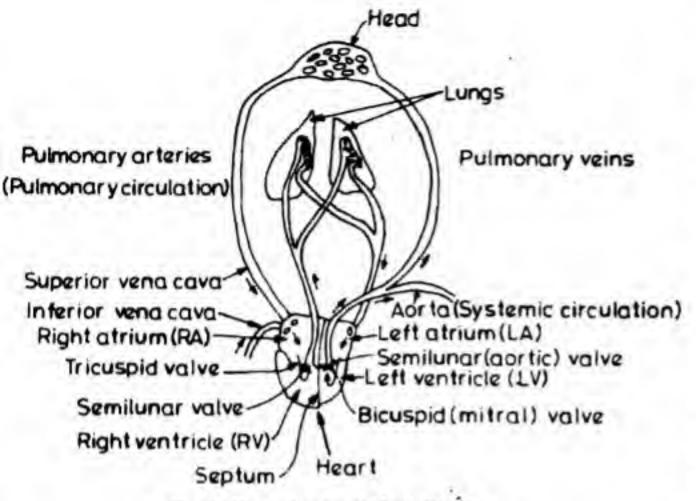


Fig. 1. Heart, lungs and blood vessels

They are a spongy mass containing about 300 million air sacks called lyeoli. Blood is present in pulmo-

ary capillaries in the lungs and

O_s-CO_s exchange takes place across the alveolar capillary membranes (Fig. 2). The total surface area of the alveoli membrane is about 70m^s and the blood pumped in by each

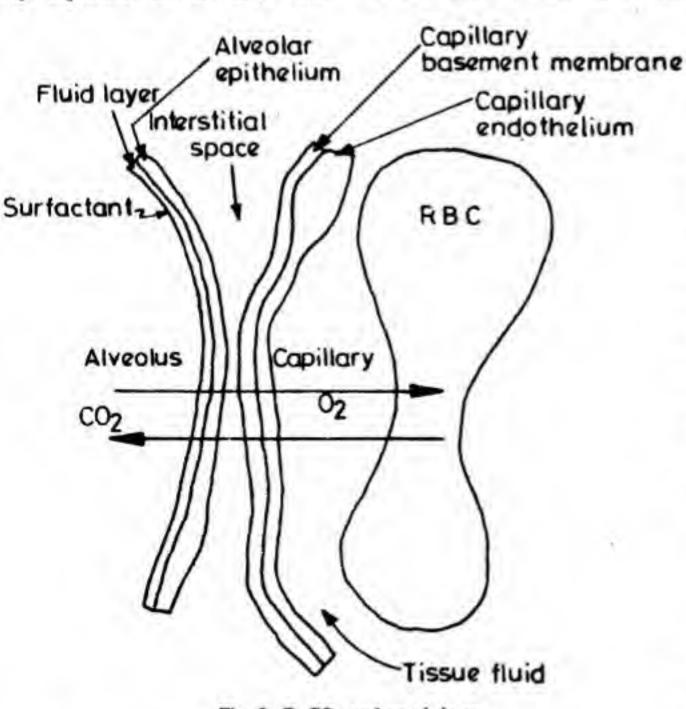


Fig. 2. O₁-CO₁ exchange in lungs

heart beat is about 70 ml whi mixes with the blood already in t lungs to form a blood film less the 0.01 mm thick in the alveol cepillaries. The diffusion of (and CO, across such a thin film very fast and, by the time the bloc traverses only half the length of the pulmonary capillaries, it is saturate with O. This takes about 0 second to occur. The oxygenate blood enters the left side of the hea and is pumped into the system circulation as mentioned earlie This must be borne in mind that th blood never exchanges its total C with CO, or vice versa. The partia pressures of O, and CO, in the bloo and the lungs under normal cond tions are given in Table 1. CO, necessary to maintain the pH of th blood close to 7.4.

Intricate as this blood circulato system is, it is surprising how well functions for the majority of th people all through their lives with out developing any serious trouble However, in some cases everythin is not right and the system malfund tions. This could be due to congenite (birth) defects diseases or injury t the heart or the lungs. Some suc malfunctions can be treated by drug or simple surgery. However, seven types of malfunctions require compl cated surgery. Some such situation are the defects in the working of th mitral or semilunar valve requirin replacement or defects in the atria septum wall or ventrical septum wall Under these conditions, the hear has to be opened to carry out th operation. During these operations the heart cannot be used to pump th

Table. 1. Partial pressures of O, and CO, blood and lungs

	Blo		
P	ulmonary	Pulmonary	gas in lungs
pCO, mm H	g 45	40	40
pO, mm Hg	40	104	104

stemic circulation and one is forced rely on an external pump.

ung bypass

If in open heart surgery, the lungs re not bypassed, as some have tried the past, the anaesthetist has to flate the lungs about 10-15 times per inute to get satisfactory oxygenation blood. This interferes with the peration. Hence, this practice has ow been abandoned. The external evice used for oxygenating the blood called the oxygenator. Alongwith the external pump, this makes up the eart lung machine.

eart lung machine

The major components of a heart ng machine are a set of pumps, an xygenator and a heat exchanger, esides a host of other minor comonents for control and regulation. he pump does the job of the heart circulating the blood and the cygenator does the job of the lungs providing for O₂/CO₂ exchange. he heat exchanger is used to graually lower the body temperature sypothermia) so as to reduce the etabolic rate and hence the enymen quirement during the operation. is again used to warm up the body 37°C at the end of the operation. Heart lung machines have been in se for over 20 years. The improveents since then have made it ossible to use these machines during perations lasting a number of hours ithout fear of any breakdown. hey are genred to provide blood rculation at a rate of upto fiters/ ninute with a pressure of 120 and of lg and blood-O, saturation above 5%. A number of factors to be hept mind in the design and construcon of such a machine asset

with blood, which is quite a rare commodity in any country, one has to use the type of oxygenature and the heat exchangers which require lesser volumes of blead.

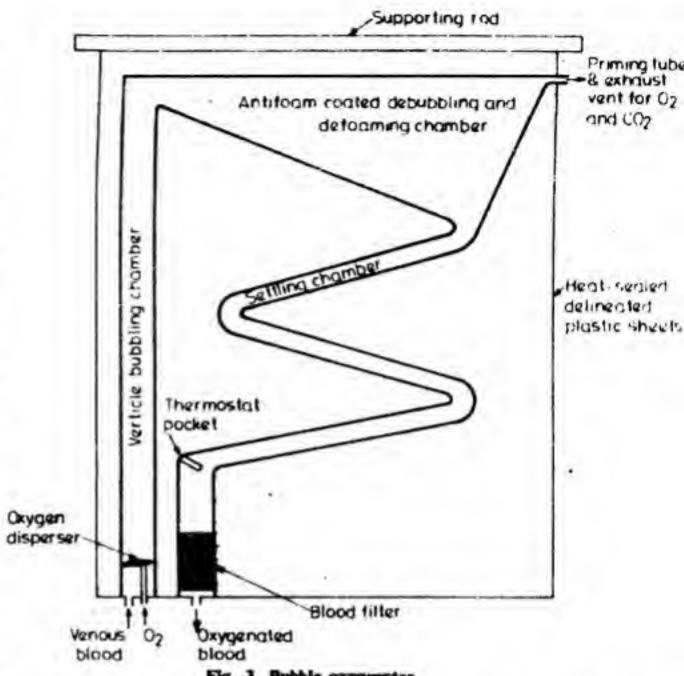
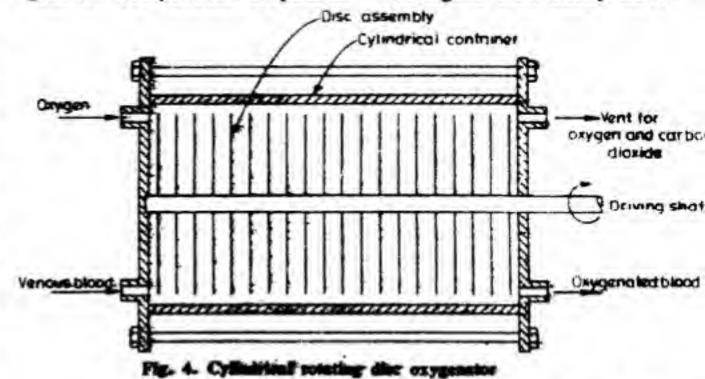


Fig. 3. Bubble oxygenator

- 2. To avoid clotting heparin 20 mg per bottle of blood is used for priming the machine. Patient is heparinized at the outset before putting any cannulae inside the heart or blood vassels. Highly polished surfaces are recommended to avoid clotting of blood.
- The parts which come into contact with blood need sterification: tygon tubings, stainless steel connections, cannulae and disc oxygenator components. Disposable
- oxygenators come presterilized an ready for use.
- 4. To avoid the high rates of shear a encountered in ordinary pump which will damage the blood cell and also to avoid the associate problems of cleaning, sterilization and leakage, only such pump should be used which do not contact the blood. The pump should preferably provide some pulsatile flow which is more physiological than steady flow.



Machine breathes for you

THE artificial lung will soon become available for temporary eplacements for conditions like sulmonary embolism, pneumonia, lirect injury to the lung and a "shock ung syndrome" following massive rauma resulting in acute respiratory ailure. It will save a number of valuable lives. It is still in an experimental tage and not available for routine se. This can take over the functions of the lungs for longer periods han the heart lung machines developed in Nineteen Fiftees.

In the artificial lung or membrane xygenator, the oxygen-carbon-ioxide-diffusion carried out in the ing, is achieved, but less efficiently, silicon rubber membrane is sub-ituted for the alveolar and capillary ssue; oxygen moves over one side the membrane and deoxygenated

venous blood over the other. The oxygen and carbon-dioxide diffusions take place across the membrane depending on their concentrations i.e., the oxygen from the air diffuses into the deoxygenated venous blood and carbon dioxide from the latter to the air. The thinnest practicable rubber membrane is far thicker than the natural lung membrane, and its total surface is only about 5 sq.m. compared to natural lung surface area of 75 sq.m. Besides this, due to slow diffusion rate, a relatively thick blood layer occurs along the membrane, which further reduces gaseous exchange. Therefore, the result is that most artificial lungs can only transfer about 250 ml of oxygen per minute, which is the normal requirement of the resting adult.

N.B.

Since the huge area of the human lung's alveolar membrane cannot be duplicated in an extra corporeal oxygenator while keeping the priming volume low, the blood film thickness in the oxygenator is more than that in the lungs resulting in a higher resistance to O, transfer. This has to be compensated for by increased partial pressure of O₂ in the oxygenator so as to increase the driving potential for O2. Also, longer contact time should be allowed between the blood and the oxygen in the oxygenator compared to 0.2 second in the lungs.

In the lungs, O₂ does not come into direct contact with the blood but the transfer occurs across the alveolar membrane. The direct contact between the blood and the oxygen results in the denaturation of some of the plasma proteins. This can be taken into account by providing an interface in the form of synthetic semi-permeable mem-

brane or a liquid fluorocarbon oxygen carrier (see 'classification of oxygenators'). With these points in mind the various parts of the heart lung machine are given below.

Pump

The pump is of roller type with no

moving parts in contact with blood stream. This is called peristic pump. Two or more rollers connected to a central shaft press flexible tube through which the bloof flows (Fig. 7). Movement of trollers forces the blood forward in pulsatile fashion simulating the puming action of the heart. The puming action of the heart. The puminate. Motion of the rollers can be reversed to suck out any accidentation air bubble in the blood line.

Whereas, almost universally the pump used is of the type describe above, there are various types of oxy genators in use.

Oxygenators

This should be able to oxygenatupto 5 liters/minute of venous bloofrom 65% saturation to above 95% saturation for a number of hour without causing any significant damage to the blood constituents.

Classification of oxygenators. This is based on the manner of the blood gas contact in the oxygenator.

- (i) Direct contact oxygenators In these the oxygen comes into direct contact with the blood
- (ii) Indirect contact oxygenators
 An interface exists between
 the blood and the oxygen
 This reduces the trauma caused

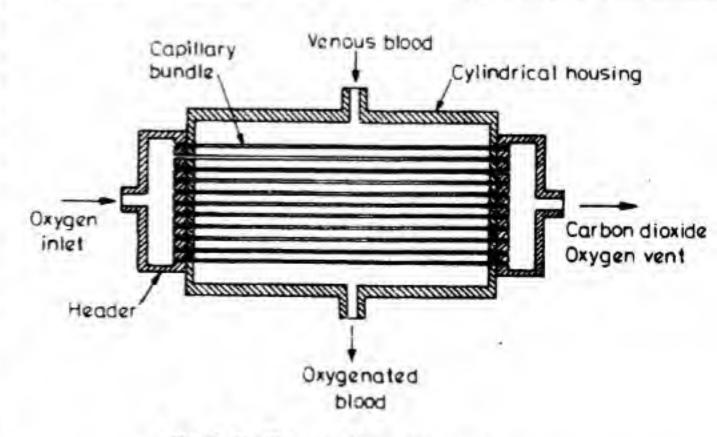


Fig. 5. Capillary membrane oxygenator

to the blood by the direct contact with oxygen. Also, these oxygenators can be used for a longer period.

Representative examples of each pe of oxygenator are briefly dis-

brect contact exygenetors

bubble oxygenator (Fig. 3). Two neets of polyvinyl plastic whereall the blood chambers and namels are delineated by heat seal ake up this oxygenator. The O₂ is abbled directly into the blood. An approvement is the incorporation of heat exchanger in the settling namber.

Cylindrical rotating disc oxygeator (Fig. 4). It consists of a large umber of this discs mounted on a haft rotating inside a cylindrical ontainer. These discs dip into a bool of blood and lift a film of blood they rotate. This film is exposed to a directly and is renewed in each otation. The extent of oxygenation in be varied within limits. This tygenator is reused after sterilizing.

direct contact oxygenators

Membrane oxygenator. Teflon and silicon rubber membranes are sed because they can be cast into any thin membranes having suffient mechanical strength and desir-

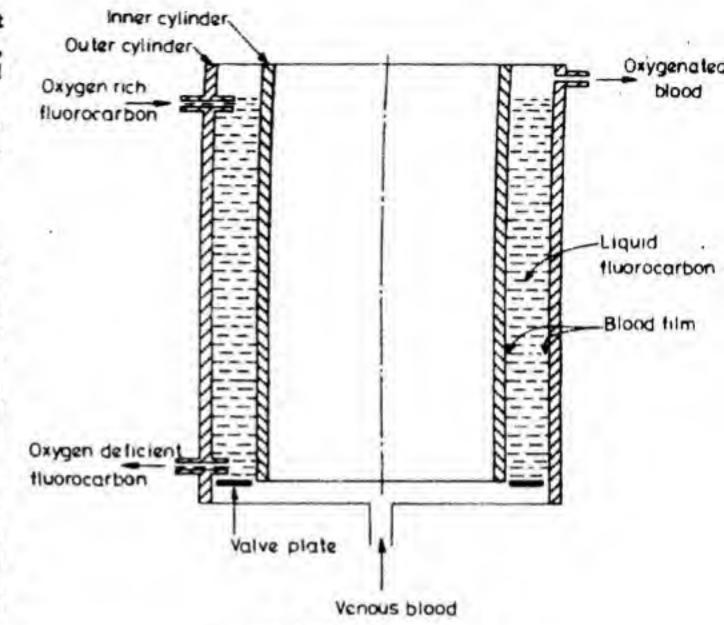


Fig. 6. Liquid-liquid oxygenator

In order to reduce the resistance offered by the blood film, the membranes have been arranged in various ways by different workers. Some of these arrangements are the capillary (Fig. 5), cascade and sandwitch types.

Liquid-liquid oxygenator (Fig. 6). A fluorocarbon liquid is used as a carrier for O_a. Venous blood contacts the fluorocarbon in the annular space between the two concentric cylinders that make up this oxygenator. The blood gets oxygenated in the process and the fluorocarbon is recirculated through an oxygenation circuit of its own.

Heat exchanger. This is usually a single pass shell-and-tube type heat exchanger with a thin annular space having a holdup volume of less than 200 ml. The blood flows in the annulus whereas the water flows through the inner tube.

Use of heart lung machine in au operation

A typical but highly simplified scheme of the blood circulation using a heart lung machine is shown in Fig. 7. A general schedule of steps taken in an open heart surgery follows. There will, of course, be variation depending upon the particular operation, the type of oxygenator used and the preferences of the surgeon.

A couple of liters of blood of the same type as that of the patient ar

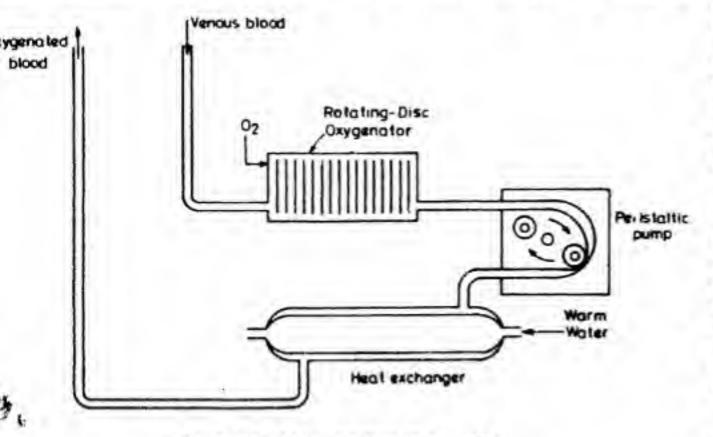


Fig. 7. Heart-long machine la operation

kept ready for priming the machine and for transfusion during the operation to make up for any loss. The machine is checked out and kept ready with a sterilized oxygenator in place. The patient is administered aneasthesia and his chest opened. The patient is given heparin, 3 mg per kilogram weight of the patient. Heparin acts as an anticoagulant for the blood.

The superior and the inferior vena cava are connected to the inlet of the machine by a Y-connection and the aorta is connected to the outlet of the machine by a straight connection. Simultaneously, the pump and the O supply to the oxygenator are started. The blood circulation is maintained at about 3 to 4 liters/ minute, enough to supply the necessary O, under hypothermia. CO, is frequently added alongwith he O, to maintain the blood pCO, and pH. The blood is passed through he heat exchanger before it enters the orta. Thus the blood and the oody can be cooled or warmed is desired. The heart is opened to erform the opration. Any blood in

the heart is sucked out. Blood left in the lungs does not coagulate because of the action of heparin. During the operation, the blood pressure in the radial artery is maintained between 80 to 90 mm of Hg and the venous pressure below 15 mm of Hg. The latter is based upon adequate urinary output which is taken to be about 20 ml/hour.

Since heparin is metabolized in the liver, reduced doses are administered every hour in prolonged operations. At the end of the operation heparin is neutralized by protamin.

As the operation comes to an end, the heat exchanger is used to warm up the body to 37°C. Also, fresh blood is tranfused to make up for any loss in the blood volume.

The patient is weaned off the pump and the incisions made in the aorta and the vena cava are sewn up.

The opeation is essentially a team work where each member plays his/ her part as per the instructions of the surgeon. In Delhi, the open heart surgery is performed at the G.B. Pant Hospital and at the All India

Institute of Medical Sciences. The are a number of other places India where such facilities exis The machine costs a lot of foreign exchange. We have designed an constructed a machine which at present undergoing tests. Th machine can also be used for isolate organ perfusion before they as transplanted.

Further reading

A.C., Textbook Guyton, Medical Physiology, Saunders Philadelphia, 1971.

2. Chakrabarti, Ghosh and Sahama Modern Human Physiology, Th New Book Stall, Calcutta, 1972

- Galletti, P.M., Advances i heart lung machines in Advance in Biomedical Engineering an Medical Physics, Vol. 2, S.N. Levine (Ed.), Interscience, N.Y. 1968.
- Nagarajan, R. and Gupta, J.P. Design and constitution of heart hing machine, presented at the 4th All India Symposium on Biomedical Engineering, I.I.T Delhi, Feb. 1974.

MEDICAL NOTES (Continued from page 558)

prolonged period, i.e., more than month. These studies clearly indiate that the duration of action of ntiestrogen can be prolonged by ppropriate modulation of the inial dose of the compound. Howver, it should be emphasised that the se of antiestrogens as post- the development of these com-

coital antifertility agents remains, still, a possibility. Probably, more organized investigations on the hormonal control of implantation in monkeys and man and the possibility of using antiestrogens to inhibit this process may lead to

pounds 'ideal post-coital pills' for contraceptive practice in women.

> M.S. SHANKARAN Lecturer in Zoology Hindu College, Delhi Univ. Delhi-7

CIENCE SPECTRUM (Continued from page 554)

oth sexes seems to be dependent on neir mutual presence. It is expected om this obligatory sexual parasitic ssociation that the male exerts imulus for the development of

ovaries in females and the vice versa. The studies conducted so far have shown that only the male attached to a female has developed testis. Similarly, gravied females were those

which had attached male sexual partner.

ZAKA IMAM

SCIENCE SPECTRUM

Moon's origin still a puzzle

OON, the dingy-looking wax-VI ing and waning orb, invokes a poet a sad countenance of a lady. he reasons why she looks so the oet doesn't know; he simply conectures them in his black and white erses, partly eulogising her suffeance and forbearance. Same is the tuation the scientists are in today. Ithough so much is known about noon's features and composition, ney are unable to present a clearut theory about its origin. Morever, the recent Apollo findings ave, instead of providing a solution, ut them in a fix: moon has become far more enigmatic object than efore.

The only benefit the lunar data ave given is the constraints, both eochemical and geophysical-withthe confines of which the models r theories about the origin of the oon should be proposed. Geocheical constraint: a layer of molten ock (about 100 km deep) covered ne original crust of moon some 100 nillion years ago; while it cooled was bombarded by meteorites for ome million years. Geophysical onstraint: moon is receding from the arth. If this be extrapolated, it is ound that moon and earth separated billion years ago long after the rmation of the oldest moon rocks. These constraints particularly your the burgeoning 'Accretion cory' (Science, Dec. 6, '74) which cludes both the chemical and hysical aspects of the problem that

lack in other theories. It has another plus point and that is: it very well fits in with the formation of the solar system.

Fission theory

This theory claims that moon was born out of the earth's womb and has many strong evidences in support. Firstly, it is now claimed that the rocks of moon could have been formed from earth's mantle material. Moon is rich in refractory elements (aluminium and uranium) that condense at higher temperatures; iron and nickel are present in small quantities, whereas volatile elements (sulphur and lead) are nowhere to be found. Secondly, moon has no central heavy core.

At the close of 19th century, George H. Darwin proposed a now abandoned theory which claimed moon to have broken loose from earth due to tidal action. The theory enjoyed popularity for several decades; today much detailed, somewhat different and modern versions have replaced it.

Earth used to spin at a period of 2.6 hrs. It was homogeneous in the beginning but, later, it differentiated to form a central heavy core and a light envelope 'mantle'. This in effect increased the moment of inertia of the system so that it spun more violently, to throw out its outer light material into space which subsequently assembled to form the moon. Another theory to reach the same

spinning cauldron of hot material It boiled off a thick cloud of metal and oxide vapours which condenses outside in the space to form as orbiting satellite. The spin of the earth provided the necessary angula momentum for the moon to rotate round it.

The objections raised against this theory are purely dynamical in nature Such a violent spinning of earth is doubted because there is no evidence to supplement it—such a rotation rate is not even that of a non-satellite planet. Moreover, it is argued that the inclination of moon's orbit to the earth's spin axis is inconsisten with this spin-off origin.

Capture theory

F. Singer and H. Gerstenkorn had done the initial work in support of this model; today numerous mechanisms are available to explain the capture and formation of moon.

One model claims that moon was captured by earth as it is. The capturing mechanism was the tidal friction in which a slow relative velocity of less than 40 m/sec is required between the two bodies. Another model argues that moon was formed out of the silicate mantles that remained in earth's field when the protomoons that fied past earth



"I like to marry your daughter She is like a moon to me! Er, of course, the fact of her origin is no mystery."

rupted or were stripped off their naterial. To accumulate a mass of noon's size, it is claimed that protonoons' total mass equivalent to that f earth is required for this process. Turther, to capture such fractured ieces, a relative velocity of 25m/sec required between the earth and the iece.

Another model claims the moon to ave formed out of the planetesimals nat were lying in a highly inclined eliocentric orbit. As we know from Massive nebular theory' (S.R., Oct. 5) that a 'chemical zoning' took lace, i.e., the composition of the bject was dependent upon its istance from the plane of earth's rbit.

The greatest hindrance to this secry comes from 'chemical zoning'. is still unknown wherefrom a body moon's composition would have volved in solar system. Suppose it ad evolved in our system, then it just be in a far off section—from here the moon would not have proached earth with a relative clocity less than 40 m/sec, and would are evaded its capture by earth.

ccretion theory

In 1862, when Lord Kelvin's paper in the solidification of the earth appared, a new theory about the origin the planets and moon was founded. claimed that moon and planets ere formed in a melted condition, hich with the passage of time cooled and solidified. But this theory was empletely rejected because of the distence of mascons, high concentrations of solid mass below the ground wel. This theory seemingly appears milar to 'Acceretion theory' but in encept, it is far simpler.

Russians have done much work in eveloping the complex 'Accretion eory'. According to their 'Small bular hypothesis' for the origin the solar system, planetary bodies and sun evolved over a period of 100

million years. During this span of time, particles in the space collided with each other and approached the still evolving earth. Some of them remained in its field and gradually built up material to form the moon. It is pointed out that these incoming objects assembled in the earth's field only when the earth was about half its present size.

This theory has flaws in that it does not explain the present size of the moon nor does it give reasons for the outer layer (geochemical constraint) of the moon which is a result of melting. The duration of accretion to be 10° years is too large a period for the matter to collide incessantly to produce heating—to melt the moon's outer layer. As an alternative, it is proposed that many large submoons might have gathered first and then collided and coalesced to produce the present moon with the production of heat during the collision.

The American advocates of this theory, whose arguments are based on 'Massive nebular theory' in which planets took very short time for their formation, claim that moon was formed within 1000 years. Collisions of the incoming particles were incessant so as to release their kinetic

energy rapidly—to heat the surface of the moon, as required.

The difference in compositions of earth and moon has also been tried to be explained. E.L. Rusko proposes that high-energy collision among the swarm of particles in the orbit of earth might have released volatile material which was swept on to earth by the solar wind. Another proposal is that since silicate mineral are more sensitive to fracturing during collision than metal minerals these must have been easily captured into earth's orbit to form silicate rich moon.

The above explanation is no considered to be the appropriate answer. The difference in composi tions is therefore one of the major stumbling blocks to this theory. More over, it is now questioned why satellites were formed only round the earth and some planets and why not for Mercury, Venus and especially Mars According to accretion theory, they should have formed round every planet. However, these obstacles are laid aside by the propounders claim ing that 'accretion process' is a complex one, and is still incomprehensible to scientists.

DILIP M. SALWI

Friendly or amicable numbers

FRIENDLY or amicable numbers are defined to be pairs of numbers such that each member is composed of the aliquot parts, i.e., divisors of the other—symbolizing mutual harmony, perfect friendship and love.

The numbers 220 and 284 are amicable, since $220 = 2 \times 2 \times 5 \times 11$ and $284 = 2 \times 2 \times 71$. The aliquot parts

of 220 are 1, 2, 4, 5, 10, 11, 20 22, 44, 55, 110 which add upto 284, whereas that of 284 are 1, 2, 4, 71, 142 which add upto 220.

The origin of amicable numbers is somewhat obscure. Iamblichus of Chalcis (about A.D. 320), a Greek Neo-Platonic philosopher, ascribes the knowledge of amicable numbers to the Pythagorean School, a view

which found little favour among later historians. In the mathematical writings of the Arabs the amicable numbers occur quite often. They play a role in the castings of horoscope, in magic and astrology, in the making of talisman and in sorcery. As an illustration we quote from the Historical Prolegomenon of the Arab Scholar Ibn Khaldun (1332-1406):

"Let us mention that the practice of the art of talismans has also made us recognize the marvelous virtues of amicable (or sympathetic) numbers. These numbers are 220 and 284. One calls them amicable because the aliquot parts of one when added give a sum equal to the other. Persons who occupy themselves with talismans assure that these numbers have a particular influence in establising union and friendship between two individuals."

The knowledge of amicable numbers spread to Western Europe through the Arabs during the Renaissance. It is through contact with the Arabs that Europe was able to assimilate the whole of Greek and Hindu mathematics, not to speak of other sciences. Amicable numbers thus find a mention in the works of many prominent mathematicians around A.D. 1500 in Europe.

Prior to the time of the French mathematician, Pierre de Fermat (1601-1665), there appears but a single set of amicable numbers, namely, the pair (220, 284). In 1936, he discovered yet another pair (17296, 18416). It is a strange historical fact that Fermat found this pair by the rediscovery and application of a rule that was found and formulated by the Arab mathematician Abul-Hasan Thabit ben Korrah as early as ninth century. This rule can be formulated as follows:

For various exponents, n, we write down in a table the numbers:

$$P_n = 3.2^n - 1$$
(1)

Thus we have

Now, if for some n, two successive terms p_{n-1} and p_n are both primes, one examines the number

$$q_n = 9.2 - 1$$
(2)

If this number is also prime, the following pair (M,N) is amicable

$$M=2^n p_{n-1} p_n, N=2^n q_n \dots (3)$$

To illustrate we observe that $p_1 = 5$ and $p_2 = 11$ are primes, and since $q_2 = 9.2^{2\times 2-1}$. 1 = 71, which is also prime, we obtain the classical pair 220 and 284 from (3). The roof of the Thabit bin Korrah Rule is not difficult but we will not deal with it here.

The next pair of successive primes in the above table is p₄=23 and p₄=47. In this case q₄=1151 is also prime and we have from (3)

which is the amicable pair obtained by Fermat in 1636. Rene Descartes, the noted French mathematician of the 17th century, in a letter to Father Mersenne in 1638 mentioned that he had been led to the same rule and had given the third pair of amicable numbers:

Corresponding to the primes of the series p₄=191 and p₇=383.

In spite of further searches later on, including those in modern times for n=1000 or less, no Thabit bin Korrah amicable pair has been discovered other than the above three.

The Swiss mathematician, L. Euler (1707-1783), took up the search of amicable numbers in a systematic manner and developed several methods of finding them. In 1747 he give a list of 30 amicable pairs which he later expanded to 61—of which two were found false in 1909 and 1914.

It is interesting to recall here the Nicolo Paganini, an Italian boy a sixteen years of age, discovered in 186 another amicable pair (1184-25 × 3 and 1210-2×5×113). This am cable pair however eluded the attention of many earlier mathematician including Euler.

It was L.E. Dickson, the 20th century American mathematician who first showed that there are only five amicable pairs for which the lesser member of the pair is less that 6233, namely: (220, 284), (1184), (2620, 2924), (5020, 5564), (6232, 6368).

Today it is, of course, not know whether there exists an infinity of amicable pairs or there are only finite number of them. In 1946 E.I. Escott, in an article in the Journal Scripta Mathematica published from America, gave a list of 390 amicable pairs. This perhaps represents a state of situation in the days before the employment of high speed electronic computers. The first man to discove an amicable pair on a computer was H.L. Rolf in the year 1965.

E.J. Lee and J.S. Madachy, in a article in the Journal of Recreations Mathematics, April 1972, publishe from America, have attempted a re view of the problem and have given list of 1095 amicable pairs discovere till 1971. They also corrected man errors of earlier lists of amicable pair Their list shows the largest of th amicable pairs being numbers in volving 25 digits. They also pointe out that the first 236 pairs in the lis constitute a complete tabulatio where the smaller member of th amicable pair is less than 100,000,000 There are 859 pairs after that wit many gaps yet to be filled in an perhaps an infinity of them beyon the largest now known.

PRASANTA CHOUDHUS
Statisticia
N.S.S.O., Govt. of Indi
Calcutta-7000:

History of non-Euclidean geometry

GEOMETRY, as its very name suggests, appeared as the practical science of measurement, the measurement of the earth. As the nistory of mathematics tells us, geometry was used in Egypt in about 2000 B.C.; then it was brought to Greece by Thales of Milatus (640-646 B.C.) who began the process of abstraction by which positions and traight edges were idealised into points and lines.

The two records (i) Rhind Papyrus 1600 B.C., kept in British Museum), ii) Moscow Papyrus (1400 B.C., tept in Moscow) speak of achievements in mathematics by ancient gypt. The constructions of pyramids till nonplus the mathematicians of nodern age. These pyramids are constructed on square bases and the couracy with which the right angles of these squares are constructed make us spell-bound (maximum tror found—12 seconds).

There still exists to-day a tunnel bout 1069.84 m long constructed n the 6th century B.C. through a ill on the island of Samos by an Eupalinus. The rchitect named onstruction of this tunnel proves low skilful Eupalinus was in geonetry. We cannot get any record of Supalinus' procedure, but this makes is greatly surprised when we think hat geometrical instruments like heodolites, etc., were not available in hose days. Eupalinus must have been conversant with various geometrical properties, was able to measure ingles accurately and to determine lifference in levels of the two ends of he tunnel with astonishing precision. from all this, we conclude that the anient Egyptians and their successors, he Greeks, were highly conversant

with the practical aspects of geometry. Thales and Pythagoras (582-510 B.C.) are regarded as the true founders of modern geometry (fully deductive in nature).

Geometry mainly deals with properties of figures in space. Every such figure is made up of various elements -points, lines, curves, planes, surfaces, etc. And these elements bear certain relations with one another ("A point lies on a line", "A line passes through a point", "Two planes intersect in a line", etc.). The propositions stating these properties are logically inter-dependent, and it is the object of geometry to discover such propositions and to exhibit their logical inter-dependence. From the ancient times geometers tried to give the subject a logical form.

Thales, the famous Greek mathematician, gave logical proof of the following propositions; (i) a diameter bisects a circle, (ii) angles at the base of an isosceles triangle are equal, (iii) vertically opposite angles are equal, (iv) angle in a semi-circle is a right angle, (v) corresponding sides of equi-angular triangles are proportional, (vi) if two angles and one side of a triangle are equal to two angles

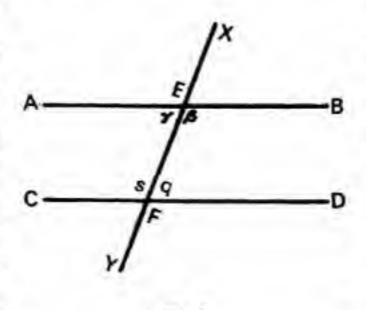


Fig. 1

and the corresponding side of the other, then the two triangles are equal in all respects.

Later Pythagoras gave logical reasoning for the proof of the following propositions: (i) in a right angle triangle the square on the hypotenus is equal to the sum of the squares of the other two sides (the famous Pythagoras' theorem), (ii) three angles of a triangle are equal to two right angles. He deduced several formulas for areas and volumes of geometrical figures (with proof) Besides these, he did much for the development of modern algebra and theory of numbers.

In fact systematic study of geome try was started by Euclid (300 B.C.) By purely logical reasoning he deve loped geometry as a consistent deduc tive science. Euclid worked at the University of Alexandria, established by Alexander, the great. This University was the centre of learning of those days. The historians say that Alexander brought many valuable works from countries invaded by him includ ing India. This may be called a type o "Brain drain" though strictly not in the modern sense. At Alexandria University, Euclid came in contact with the works of Thales, Pythagoras Hippocrates and all other works brought from various countries. He was a skilful geometer. By logica reasoning he set forth many proposi tions and their proof in his widely read book "Elements". Next to 'Bible', Euclid's "Elements" is the most widely read book of the world The geometry taught in high schools of these days is essentially a part of "Elements" with a few unimportant changes.

To study the history of development of non-Euclidean geometry, we must know Euclid and his works first. As in any deductive science we prove any proposition with the help of previously proved propositions, so we do in geometry also. But the problem arises in proving the first theorem or proposition. We require some notions or ideas whose validity we accept without any argument. In his Book I of "Elements" Euclid started with few definitions, five 'common notions' concerning magnitudes and five postulates. The plan of his book is as follows.

Definitions of a few geometrical entities

Point, line, straight line, angle, plane, perpendicularity, rectilinear figure, triangle, parallel lines are defined. Euclid defined parallel lines as follows: "Parallel straight lines are straight lines which being in the same plane and being produced indefinitely in both directions do not meet each other in either direction."

Common notions (Euclid called these "Axioms")

- (i) Things which are equal to the same thing are also equal to one another.
- (ii) If equals be added to equals, the wholes are equal.
- (iii) If equals be subtracted from equals, the remainders are equal.
- (iv) Things which coincide with one another are equal to one another.
- (v) The whole is greater than the part.

Postulates

- (i) A straight line may be drawn from any point to any other point.
- (ii) A finite straight line may be produced to any length in a straight line.
- (iii) A circle may be described with any centre and at any distance from that centre.
 - (iv) All right angles are equal.
- (v) If a straight line meets two other straight lines so as to make the two interior angles on one side of it together less than two right angles, the other straight lines will meet, if produced, on that side on

which the angles are less than two right angles.

The fifth postulate is known as Euclid's "Parallel postulate" or "Parallel hypothesis". The very presentation of this fifth postulate, that is, its theorem-like form influenced the geometers to deduce it as a consequence of other postulates.

It is astonishing to note that for the later 2000 years Greek, Arabic, Italian, German, English, French and Hungarian schools worked hard to prove this "Parallel hypothesis" but all in vain. In various periods, many geometers proceeded with peculiar reasoning. The supposed proofs of the fifth postulate had always the same fate.

An implied assumption proceeding from the Euclidean postulate had been introduced by the architect of such proofs. The futile attempts to prove the postulate yielded the positive mathematical assertion that "certain axioms (postulates) set at the place of parallel postulate in the Euclidean system give together with the remaining axioms (postulate) the theorems of Euclid". This is the direct consequence of the attempts to prove the fifth postulate; an indirect consequence being the birth of different non-Euclidean geometries which are as consistent as Euclidean geometry.

Given here is a brief history of the said attempts.

Ptolemy (Greek geometer, 2nd

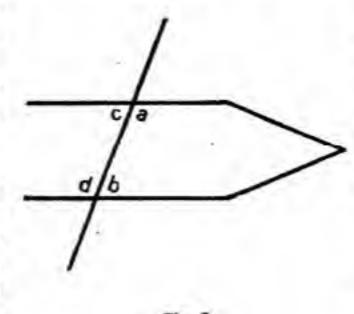


Fig. 2

century A.D.) proceeded to prove Euclid's fifth postulate with curious reasoning. He first proved the proposition—"A straight line falling on two parallel straight lines makes the interior angles on the same side equal to two right angles." (part of proposition 29 of Euclid).

AB and CD are any two parallel straight lines. The transversal XY meets them in E and F. Let p, q be the interior angles to the right of EF and r,s be the two interior angles to the left of EF. Clearly there are three possibilities—the sum of p, q may be greater than, equal to or less than two right angles. Ptolemy assumed that it any of these cases were true for one pair of parallels, it would be equally true for any other pair. Now EB and FD are parallel and so also EA and FD. Hence, if p and q be greater than 2 right angles, then r and s will also exceed 2 right angles for which the sum of the four angles p, q, r, s will exceed 4 right angles. But this can never happen; the sum of p, q, r, s is always equal to 4 right angles because it is the sum of the straight angles at E and F. Hence, p, q together cannot exceed 2 right angles. In the same way it can be shown that p and q cannot be less than 2 right angles. This establishes that the sum of the interior angles on the same side of a transversal intersecting two parallel lines is 2 right angles. Now Ptolemy took up "parallel hypothesis" proper. If possible let us assume that the lines do not meet on the side on which the sum of the interior angles is less than 2 right angles. It they do not meet on one side they will not meet on either direction Then the lines must be parallel lines so the sum of the interior angle will be 2 right angles which contradict our assumed hypothesis. Hence the straight lines are not paralle and they must meet at a finit

distance. Let us assume that the straight lines meet on the side of

which the sum of the interior angles xceeds 2 right angles. Now from ig. 2, the sum of a and b exceeds right angles, but the sum of a and c a straight angle, i.e., 2 right angles. lence, the angle c is less than the ngle b, but this contradicts Euclid's 6 (in any triangle the exterior angle greater than either of the interior pposite angles). Hence, the lines eet on that side on which the sum f the interior angles is less than 2 ght angles. This proves the "parallel ypothesis". But this is practically no dependent proof of the fifth postuite, i.e., it is not established as a onsequence of the other postulates. Next came Nasir-Eddin (Arab

athematician, 1201-1274) whose ork deserves to be mentioned. He it in the forefront the theorem on e sum of the angle of a triangle and s exhaustive nature of reasoning ew attention of others. He proved theorem first which is as follows: (C, BD are perpendiculars erected the extremities A and B of a raight line AB. If now AC and BD made equal to each other and CD joined then each of the angles CD and BDC will be a right angle d CD will be equal to AB." After Nasir-Eddin proved "Three angles a triangle are equal to 2 right gles." Then with the help of Pasch's iom (if A, B, C, be three points not ing on the same straight line and be a straight line lying on the ane of A,B,C, not passing through y of A,B,C, and if 'a' passes rough a point of AB, then it must et BC or AC), Archemedes' axiom two segments are given, there is ways some multiple of the one ich is greater than the other), sir-Eddin proved the fifth postue in different cases.

Next, the English mathematician hn Wallis (1616-1703), the Italian thematician Gero Lamo Saccheri 567-1733), the Swiss mathematician han Heinrich Lambert (1728-1777), the French geometer Adrien Marie Legendre (1752-1833), the Hungarian mathematician Wolfgang Bolyai (1775-1856) (regarded as one of the founders of non-Euclidean geometry) proved the fifth postulate by their own way of reasoning but none could prove the same as a consequence of the remaining postulates.

The unsuccessful attempts to prove the fifth postulate yielded the same result that the trouble-creating postulate could never be proved and that any other hypothesis about parallels could be substituted in its place and a different geometry as consistent as Euclid's would follow. This paved the way for discovery of 'Non-Euclidean geometry'.

By the term "Non-Euclidean Geometry" we understand a system of geometry built-up without the aid of Euclid's 'parallel hypothesis' while it contains an assumption as to parallels incompatible with that of Euclid. The name 'Non-Euclidean Geometry' was first used by the German mathematician C.F. Gauss (1777-1855) to describe a system of geometry which differs from Euclidean geometry in its properties of parallelism. He was the first who thought of a geometry independent of Euclid's 'parallel hypothesis', but he dared not express his revolutionary views for about 50 years for his fear of being accused of heresy. (His idea of developing geometry discarding Euclid's fifth postulate could have invited criticism because Euclid's geometry was accepted by all and sanctified by the tradition of many centuries). He too participated in the traditional abortive attempts to prove Euclid's 'parallel hypothesis' from 1792 to 1813. After 1813 he overcame the customary prejudice and his letters written to his favourite disciple F.L. Wachter (1792-1817) reveal that he thought of an 'Anti-Euclidean' or 'Non-Euclidean geometry.'

Gauss expressed his views only when the works of Nikolai Lobats chewsky (Russian, 1793-1856) and l Bolyai (Hungarian, son of Wolfgan Bolyai, 1802-1860) were published For this reason Gauss was deprived of his credit of independently deve loping 'Non-Euclidean geometry' a the first man. Gauss's apprehension was not baseless. Lobatschewsky and Bolyai received neither praise no even any recognition from the mathe maticians of those days. On the contrary, their works were described as the futile research of eccentric men The mathematicians of those days could not even imagine of a geometry independent of Euclid's ideas. It is reported that a renowned mathematician of Russia of that period described the works of Lobatschewsky as a satire directed against mathematicians.

The new system of geometry was independently developed by J. Bolyai in Hungary in 1832 and Lobatschewsky in Russia in 1830. Lobatschewsky was a professor at Kazan University. He published his first paper 'On the principles of geometry' in the 1829-30 numbers of a journal which appeared in Kazan but did not reach other countries. Bolyai, an officer of the Austro-Hungarian army carried out his researches independently and published his works in a paper titled Appendix Scientium Spattiabsolute Veram exhibens in 1832. Thus the priority of discovery went to Lobatschewsky and Non-Euclidean (hyperbolic) geometry is accordingly also called Lobatschewskian Geometry. It is truly amazing when we find that both the scholars carried out their researches based on the properties of horosphere (by horosphere we understand a surface consisting of all points symmetrical to a given point about the lines of a bundle of parallels). Later, another system of geometry differing more radically from Fuclid's was suggested by Bernhard

iemann (1826-1866) in Germany and Arthur Cayley (1821-1895) in Ingland. It was Felix Klein (1849-225) who first tried to unify all the fferent systems of geometry. He sed the names 'parabolic', 'hyperblic', and' elliptic' for the respective stems of geometries of Euclid, olyai-Lobatschewsky and Riemannayley.

Different systems of geometry were eveloped by replacing Euclid's fifth ostulate by newer ones and keeping her postulates unchanged. Lobats-ewsky and Bolyai suggested the llowing substitution for 'parallel pothesis': "Through any point in e plane there are two lines parallel a given line."

Riemann's substitution was as llows:

"Through a point on the plane no ie can be drawn parallel to a given he". Clearly these are distinct deviaons from Euclidean geometry in hich there can be only one parallel be drawn from a given point to a ven line.

The works of Riemann were of eatest significance. He developed geometry which was a very general ence and was known as 'Rieman-an geometry' whose special cases the Euclidean and the Non-aclidean geometries.

Though the name 'Non-Euclidean cometry' has been wisely suggested show clear distinction from Euclidean geometry, some mathematicus aptly call Euclid the father Non-Euclidean geometry for his ength of genius in introducing a fifth postulate which paved the sy for the development of Non-iclidean geometry.

The distinctive features of the ee geometries are as follows:

- i) In Euclidean geometry, three gles of a triangle are always equal two right angles;
- ii) In Lobatschewskian geometry, ee angles of a triangle are always

less than two right angles;

(iii) In Riemannian geometry, three angles of a triangle are always greater than two right angles.

Riemannian geometry is of greatest significance and it is the most general science. Further discussion about it is beyond the scope of this article and also of any elementary discussion.

At this stage one may raise two worthwhile questions: (i) which of the geometries is correct? (ii) which of the geometries has got the greatest utilitarian value?

To answer the first question we shall consider the following:

- (a) 'Correctness' is a vague term when applied to a science like geometry which is a process of abstraction.
- (b) Propositions of geometry are self-consistent creations of human mind based on a set of assumed results, a set of accepted procedures, a set of abstractions of common sense with sound logic.
- (c) A triangle of geometry cannot be constructed in a laboratory and its properties cannot be tested in laboratory experiments. Considering all these points we can say that any self-consistent geometry is as correct as any other science.

Let us now consider the second question. The earth on which we live is almost spherical in shape. Which of the geometries will be employed in

surveying and other works of practi cal measurements on the surface of the earth? Geometry on the surface of a sphere is Riemannian, it canno be Euclidean. Straight line being the shortest distance between two point and shortest distance of the surfac of a sphere being measured along the arc of a great circle (circle on the sphere with the centre of the sphere as its centre), great circles are th straight lines on a sphere. Now two great circles always intersect, in othe words no great circle can be drawn parallel to a given great circle. Fo this, the geometry on the surface of the earth is Riemannian. When w consider a small area like a flat foot ball ground on the earth, Euclidean geometry can be used on that are: (straight lines are small parts of grea circles on this flat osculating region and the curvature is neglected). Bu the path of a non-stop aeroplane flight is invariably a great circle The analogy of the flat footbal ground on the surface of the earth enables us to understand the parti cular property of Riemannian geometry which helps us visualize Eins tein's development of the invariant theory of gravitation. Einstein's law of gravitation requires that the geometry governing the observations in a gravitational field must be Ricmannian.

JYOTIRMOY HU

What cosmetics are made of

COSMETICS (soaps not included)
are applied on the human
hody to improve and beautify appearance. However, they usually do so
temporarily. This is because the
human body cannot be fed through

skin which is mainly an organ o excretion.

The use of cosmetics to imitate the natural radiance of youth dates back to 4000 B.C., as revealed from earlies records found in Egypt. Princesses ith wine (alcohol) to improve their omplexion, while others used milk or the same purpose. Indians were so aware of the technique of body ainting, dyes and pigments, fats and ils.

Nowadays, the need to keep skin ealthy and to prevent from it the epletion of natural oils and moisture growing because bathing soaps are the skin dry and the urban mosphere is heavily polluted by noke, dust and dirt.

inds of cosmetics

There are three types of cosmetics: creams, lotions and emulsions for in and hair; (ii) make-up preparaons such as powders, rouges, lipicks and nail-polish; (iii) toiletries ich as deodorants.

reams

Creams are of various kinds. Cold cam is an emulsion of oil live or mineral) and water. The nulsifying agent is bees wax, in nich a perfume is also added. It cludes cleansing and lubricating



"What counties are made off viously: they are made of our mands for thems!"

creams. The cleansing cream contains a solidified mineral oil that melts down as it touches the skin. The liquid mineral oil penetrates the fine crevices of the skin and gently dissolves accumulated grime and makeup. On the other hand, lubricating creams are massage creams which contain lanolin and its derivatives. Lanolin is wax obtained from sheep wool and has been considered an excellent substitute for natural oils secreted by the skin. This cream overcomes dryness and makes skin soft and pliant. Addition of vitamins and esterogenic hormones is controversial and is unlikely to produce favourable effects on skin. The term nourishing cream which is sometimes applied to lubricating creams is therefore a misnomer.

For preparing cold cream, place in a pan one litre light grade mineral oil (specific gravity 0.84 to 0.865), 53 gm cholesterol, 26 gm lanolin anhydrous and 185 gm sun-bleached bees wax. In another pan place 500 ml. water and 14 gm borax. Heat both mixtures upto 65°C and pour slowly borax solution into mineral oil mixture with constant stirring. When the temperature is around 40°C-50°C. add 4 gm of a perfume oil. This is lubricating cream which could supplement the natural oils removed from the skin by the solvent action of bathing scap.

Vanishing creams are so called because they seem to disappear when rubbed on the skin. It is a non-greasy cream used either as a protective film on the skin or to create a smooth foundation for make-up. Vanishing cream consists of a steam acid-scap emulaified with glycerol and water. This is often supplemental with various eiteand synthetic hydrophilic substances. Secretimes it may also contain landing cetyl alcohol, vegetable oils and mineral oils for easy spaceding and organic beneatiles triethanolamine for medilying scape

When rubbed, water evaporate leaving an almost invisible film stearic acid on the skin which there looks smooth.

Bleaching creams are cold cream containing ammoniated mercury, h drogen peroxide and sodium perb rate. Instead of improving, it ma irritate the skin. On the other hanastringent creams contain alum zinc compounds. Cuticle cream oil consists of castor, mineral oils an glycerin containing sodium laury and a mild antiseptic. The creat keeps the cutiele soft and plian Cuticle remover is a dilute solution of potassium hydroxide that softer the cuticle and makes it easy to n move the dead-skin that forms aroun the nails.

Lotion and emulsion

Skin tonics or tonning lotion contain perfumed ethyl alcohol an water. They are applied to the ski after the removal of make-up. The act as an astringent to produce pleasant sensation of freshness. Handlotions consist of an emulsion of soap, glycerin, oil and a gum. The absorb superficial moisture and form a thin protective layer over the skin They keep the skin soft and prevent chapping.

Hair preparations

Hair preparations include sham poes for eleaning, tonics for health of hair, lotions for hair groom ing and to give it a sheen Shampoos are bathing soaps prepared form coconst, palm, olive or almond oils. Soupless shamposs are synthetic determents which comple tely degreese the hair and, threefore are inferior to comp shampoon Dry shampees comist of infunories or colloids knollin. All themelescoing agents are alkaline and netemperior to natural products which associighthy acidio such as curd proposed from skimmed militared infinion of dilect

Fig. 1. Abletic acid

ruit of Phylanthus emblica (Aoula) water. Both clean the scalp and air wonderfully well. The use of urd also retards growth of fungus esponsible for causing dandruff. emblica strenghthens and promotes rowth of hair.

lair dyes

These are hair cosmetics. The atural dyes prepared from henna or alnut are harmless but they make air stiff. An extract of henna leaves dilute alcohol gives a brown ye. It could be darkened further y adding ammonia. Also pulped alnut skin when extracted by either lcohol or cotton seed oil makes a ark brown dye. Metallic dyes are rritating to the scalp. The least armful metallic dye is made by nixing 2 gms ferrous sulphate, 85 ms glycerin and 1.5 litres water. f silver nitrate is used, hair first soaked in a solution of potasium sulphite. The solution of siler nitrate is applied when hair is vet with the sulphite. Organic dye ased on p-phenylenediamine and -tolylenediamine when enetrate the hair shaft and form asoluble brown dye when oxidised y air or hydrogen peroxide. lowever, dyes have no permanent ffect on hair.

ace powders and rouges

Talcum powder is finely powdered alc, Mg₈H₂ (SiO₃)₄, or soapstone

containing a suitable scent. Face powders consist of tale, magnesium carbonate, kaolin, chalk, magnesium stearate, zinc stearate, zinc oxide and titanium dioxide. Kaolin is used for adhesion to the skin, chalk for absorbing perspiration, tale for a slippery texture and zinc oxide or titanium dioxide to hide imperfections of the skin. The colouring agents are ochre, sienna or certified organic dyes. Careful blending and adjustment of particle size are necessary to satisfy the requisites of a face powder. Cake face powders contain a little fat or oil and a gum which acts as a binder. The mixture is pressed into cakes which are applied with a pad or puff. Liquid face powders are powders suspended in water or non-oily emulsion.

Rouges are sold in cream, paste or powder form. Cream rouges contain a pigment in a cosmetic cream base while paste-rouges consist of colours, fats and waxes. Powder rouges are same as face powders containing colouring matter and gum solution as a binder.

Muscara

Muscara is a mixture of pigments, waxes and synthetic resins in a volatile solvent. It consists of carbon black, brown iron oxide, a mild soap, triethanolamine stearate and mixtures of carnauba wax, beeswax and spermaceti. While carnauba wax is obtained from Coyrpha cerifera, a Brazilian palm, spermaceti wax is extracted from the sperm whale. Cream tube muscara contains water in addition. Muscara is applied to the eye lashes with a wet brush. After the solvent evaporates, the muscara on the lashes becomes highly resistant to water.

Lipstick

Lipstick is a thick waxy face cream which is coloured and perfumed. It consists chiefly of castor oil, beeswax and a dye such as tetrabromofluorescein. Fatty acid esters of glycerol and glycol are often substituted for castor oil. Paraffin wax or
carnauba wax may also be used.
Lipstick is made by grinding the pigment and mixing it with melted wax
and oil. After heating for sometime,
it is cooled to 45°C and poured into
molds for hardening. Castor oil
acts as a solvent for the dye and its
viscosity helps colour stay on the lips.

Nail polish

The modern nail polish consists of nitrocellulose dissolved in ethyl or butyl acetate. A plasticizer or softener to prevent brittleness and a resin or gum to improve adhesiveness are also added. Dyes are organic lakes which are made up of metallic hydroxides on the surface of which a dye is adsorbed. The presence of titanium dioxide makes the polish opaque. Acetone can be employed as nail polish remover.

Toiletries

Shaving creams (lathering or nonlathering) wet and soften the beard and keep the individual hair upright making it easier to cut with the razor. Lather shaving creams are potassium stearate soaps containing more water than present in ordinary soaps and a little saponified rosin The latter is obtained from species of Pinus family and mainly consists of acids of the abietic type (Fig. 1) The saponified rosin lowers surface tension and thereby stabilizes lather The pressurized or aero-sol type shaving cream contains triethanola mine stearate, which is mor soluble than even potassium soaps Brushless shaving creams are modi fied vanishing creams containing wetting agent and a humectant which is a substance like silica gel used to retain moisture. In all these creams water is the main beard-softening agent.

lotions consist of After-shave cohol, water, perfume, astringent nd an antiseptic. They are refrening and styptic.

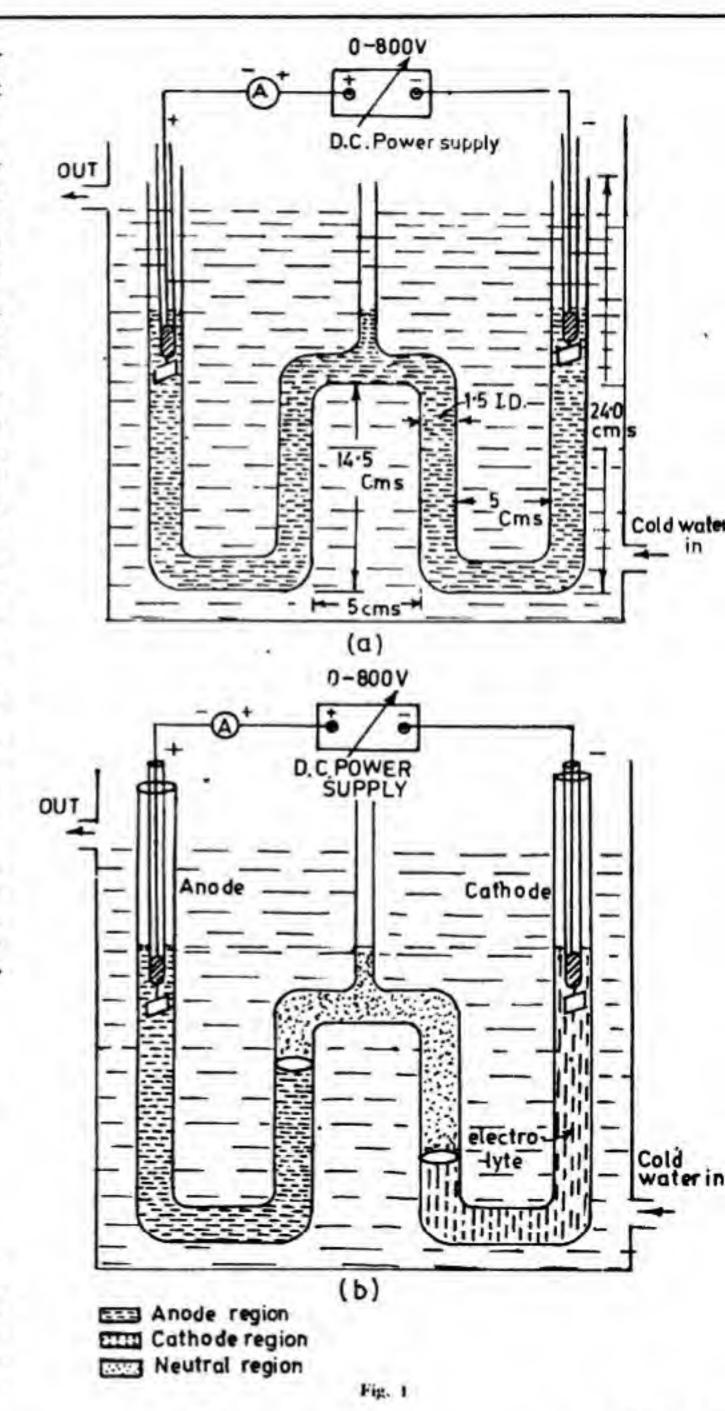
Anti-perspirants decrease the flow perspiration. They are talcium owders containing aluminium com-Deodorants ounds. ecomposition of perspiration which roduces objectional odour. He-

achlorophene and compounds of reconium are used as deodorants. Depilatories remove unwanted hair. then applied, they loosen hair roots nd soften the hair which are washed way. The earliest depilatory is usma. It consists of quick-lime and piment (As2Sa) and is mainly used remove hair from animal skin. thers are made of strontium and reted sulphides. Calcium salt of ioglycolic acid, HS.CH.COOH, also used as depilatory. It has a ilder odour as compared to sulhides. All depilatories leave a ar on the skin unless applied with most care. Depilatory waxes are ade of rosin and wax mixtures. he melted wax mixture is applied to airy area and allowed to harden. hen pulled, the hair comes off.

P.S. DUBLY Deptt. of Chemistry Bareilly College Bareilly

Desalination of water : a novel technique

URING the electrolysis of inorganic salts, particularly those ontaining large coloured anions .g., potassium dichromate, sodium anadate, etc.) in a W-shaped elecolytic cell, a very interesting pheno-



senon of the formation of two very sarp boundaries corresponding to cidic, neutral and basic zones has sen observed. Similar results were so noticed with various dye olutions, particularly the sulphonic cid dyes. The boundary formation is such cases is accompanied by inhibition of ionic migration, for which to explanation is apparently available. This interesting phenomenon ad led to the idea of testing this echnique for desalination of water.

When sea water is electrolysed in a

V-shaped electrolytic cell (Fig. 1a), ne magnesium ions present quickly ot precipitated at the cathode as menesium hydroxide, which could e visually observed. Simultaneasly, the solution in the anode ompartment turns slightly yellow ue to the liberation of bromine. large amount of heat is generaed in the central compartment, which has to be dissipated by a uitable cooling arrangement. The urrent initially rises, records a naximum and then gradually deceases until it eventually falls pracically to zero due to the cessation of onic migration. At this point, the whole of the electrolyte resolves itself nto three distinct zones (Fig. 1b): i) the alkaline zone in the cathodic ompartment consisting of mostly odium hydroxide together with small uantities of KOH, Ca(OH), and Mg(OH), (ii) a column of pure esalinated water in the central compartment, and (iii) an acidic zone n the anodic compartment which s a mixture of acids, mostly consising of sulphuric acid.

This experiment seems to offer a novel technique for desalination of water in a simple and clean way. The recovery of costly and commercially important byproducts such as magnesium hydroxide, bromine, soda, lime and sulphuric acid, apart from an adroit channelization of the tremendous amount of

heat generated in the central zone (such as for the generation of power which could make the process self-sustaining) seems to be conducive in rendering the process reasonably economical. The quantity of pure desalinated water obtained in this process could be increased by

suitable experimental manipulations.

Attempts are underway to scale-up and make this process continuous.

S.S. DARA

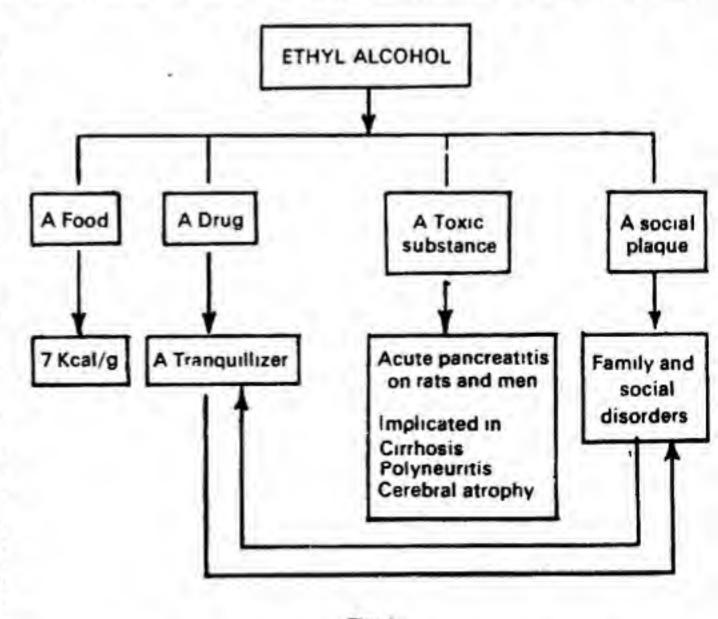
Prof. of Applied Chemistry
Visvesvereya Regional
College of Engg., Nagpur

Biochemistry of alcoholism

MUCH of our scientific thinking on alcohol has its foundations in scientific advances in the last century. With the emergence of organic chemistry, ethyl alcohol was given its name (now ethanol) and formula and became a central point in the study of carbon compounds. Curiously, its metabolic eff cts have not drawn the scientific attention

they deserve. In this article we shall study the metabolism and its effects on the body organs.

Ethanol is a food, a tranquilizer, toxic substance responsible for much human degradation, and a social plague (Fig 1). As a food, ethanol is high in calories. It produces 7 calories per gram during metabolism compared to 4 calories per gram



Pig. 1

produced by carbohydrates and protein and 9 calories per gram produced by fat. This is an advantage in feeding bed-ridden patients unable to eat. A patient who consumes half a pint of alcohol, supplied steadily in a salt-water solution over a 24-hour period, will not suffer any symptoms of intoxication and will receive 1300 calories.

Alcohol as a drug affects behaviour because of its action on the brain. The most important effect of alcohol on the brain is its depressant or sedative action. These effects are related not necessarily to the amount of alcohol drunk but to the alcohol concentration in the blood. Very low blood-alcohol levels usually produce mild sedation, relaxation, or tranquility. Slightly higher levels, at least in some people, may produce behavioural changes which suggest stimulation of brain—garrulousness, aggressiveness, and excessive activity. At still higher levels, incoordination, confusion, disorientation, stupor, anesthesia, coma, or death results. According to a report of the U.S. National Institute of Mental Health, blood-alcohol levels upto 0.05% will induce some sedation or tranquility; 0.05% to 0.15% may produce ack of coordination; at about 0.15% to 0.20% intoxication becomes obvious; 0.3% to 0.4% may produce unconsciousness; and levels of 0.5% or more may be fatal.

Absorption

Ethanol is freely miscible with all body fluids and is absorbed relatively quickly—some through the mucous membranes of the mouth and stomach. The most rapid absorption takes place in the small intestine where 90 % is absorbed. Absorption is so complete that no alcohol is found in the feces. Absorbed alcohol is distributed in all body fluids in proportion to the water content of the fluid. Consequently, alcohol

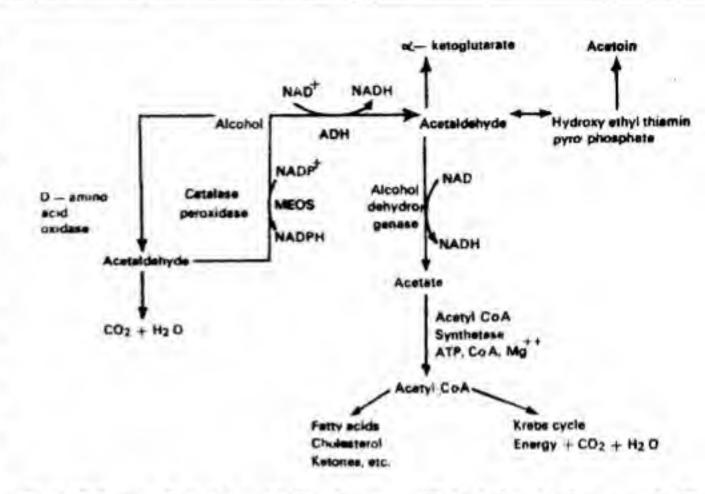


Fig. 2. Pathways of alcohol metabolism in man. ADH alcohol dehydrogenase MEOs microsomal ethanol oxidizing system

may be detected and quantitatively measured in blood, urine, cerebrospinal fluid, and water vapour borne by expired air. Absorption can be markedly influenced by a number of factors such as alcohol concentration, other chemicals in the beverage, presence of food in the stomach, speed of drinking, emptying time of the stomach and body weight.

Although most of the ingested alcohol is metabolized, from 2% to 5% is excreted chemically unchanged, mostly in urine, breath and sweat.

Metabolism of alcohol

Once absorbed and distributed by the blood, alcohol undergoes metabolic or oxidative changes. The main site of metabolism of ethanol is the liver, although some other tissues, e.g., kidney, muscle, lung, intestine and possibly even the brain, may metabolize small quantities. Over 90% of the alcohol consumed is disposed of by oxidation into CO₂ and H₂O. This oxidation takes place through several steps. Fig. 2 shows the main pathways of ethanol metabolism. The first step in the

metabolism of alcohol is its conversion to acetaldehyde. This occurs almost exclusively in the liver. It is generally recognized now that three enzyme systems can oxidize ethanol to acetaldehyde: alcohol dehydrogenase (ADH); the microsomal ethanol oxidizing system (MEOS), and catalase acting as a peroxidase in the presence of an enzymatic generator of hydrogen peroxide.

Alcohol dehydrogenase (ADH)

This zinc-containing enzyme has NAD+ as a confactor, an optimum pH of 10.8, and is found in the soluble cytoplasm of liver cells. The thermodynamic equilibrium of the ADH reaction in vitro is in favour of ethanol formation, but oxidation occurs because acetal-dehyde and NADH are readily metabolized by other enzymes.

Microsomal ethanol oxidizing system (MEOS)

This system seems to be located exclusively in the liver, and its optimum pH, 6.7-7.4, is more physiological than that of ADH. Its most

Ple. 3

Cytochrome P -450

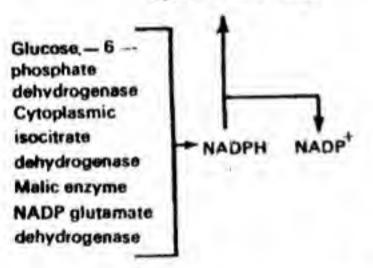


Fig. 4

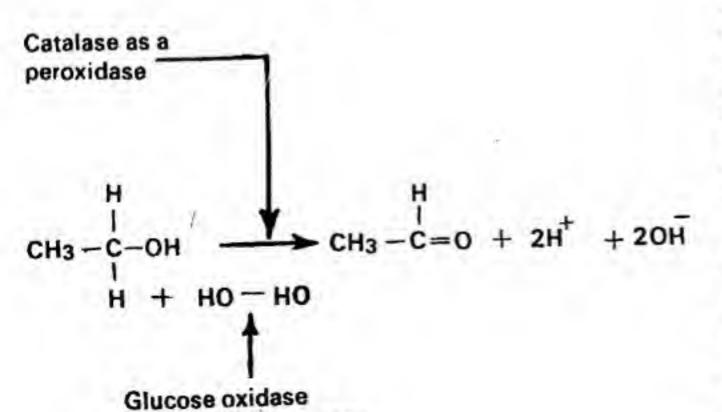


Fig. 5

D-amino acid oxidase

Xanthine oxidase

striking feature is its utilization of NADPH to activate molecular oxygen. The systems which can furnish NADPH are glucose-6-phosphate, soluble isocitrate dehydrogenase, the malic enzyme producing pyruvate from malate, and the glutamate dehydrogenase producing alphaketoglutarate and NH₄⁺.

Peroxidase-xanthine oxidase-catalase system

Some ethanol may be oxidized by the peroxidase xanthine oxidase-catalase system, and possibly other oxidases both in liver and plasma. In the plasma of intoxicated alcoholics there appears to be an enzyme system able to oxidize ethanol, activated by AMP and D-amino acids, and inhibited by CNT. The evidence for the peroxidative pathway of ethanol oxidation in man appeared to be an increase in peroxisome number in the alcoholics and a rapid oxidation of ethanol in the intoxicated alcoholics.

The acetaldehyde formed in the first oxidative step in the metabolism of ethanol is converted to acetate, a reaction catalysed by aldehyde dehydrogenase, utilizing NAD*, as cofactor, and eventually to acetyl-CoA. Acetyl-CoA is oxidized through the citric acid cycle; ultimately, carbon dioxide and water are formed. Acetaldehyde can also be converted to other subtances such as acetoin and hydroxy ketohexanoic acid.

Metabolic effects of oxidation of

The paths of oxidation of alcohol are through acetaldehyde and acetate to carbon dioxide and water, generating NADH through the main pathway. Reduction of NAD+ to NADH results in various metabolic changes.

A major metabolic change is the synthesis of fat which appears a fatty infiltration of the liver. The is suggested by experiments with human liver that demonstrate depression of gluconeogenesis and CO₃ formation during alcohol oxidation. Another effect of ethanol metabolism is inhibition of the Embden-Meyerhof pathway of glycolysis. The mechanism would be either the increase in the NADH:NAD+ ratio, inhibiting the enzyme glyceral-dehyde-3-phosphate dehydrogenase, or the competitive inhibition of the same enzyme with ADH for their common factor NAD+.

Among the additional effects of the NAD-NADH shift caused by alcohol oxidation is hyperuricemia (excess of uric acid in the blood), resulting from a decrease of uric acid excretion which explains the long recognized association of drinking with gout. This condition is common in drunken persons and infusions of alcohol cause it by raising blood lactate which is known to suppress excretion of uric acid.

Cirrhosis of the liver is overwhelmingly associated with alcoholism. Cirrhosis is a disease marked by progressive destruction of liver cells. The amount of damage caused by alcohol depends upon the amount and period over which it is consumed.

The liver is important for both storage and metabolism of certain vitamins, and interference with its functions by alcohol can therefore cause nutritional deficiencies. instance, chronic intake of ethanol reduces the amount of active form of vitamin B, which is one of the vitamins most intensively studied in alcoholism. Thiamine is converted into its pyrophosphate, and alcohol inhibits this phosphorylation in liver. This results in thaimine deficiency. The symptoms differ from those of beri-beri and the illness is known as Wernicke's encephalopathy which occurs in alceholics.

Drinking alcohol affects hormones secreted by the adrenal cortex and

by the adrenal medulla. Cortisol levels are increased during drinking and withdrawal. High levels of aldosterone, 18-aldocorticosterone, occur during heavy alcohol intake. A large increase in urinary excretion of ephinephrine, norephinephrine (hormones secreted by the adrenal medulla) and their metabolic products is found during heavy alcohol intake and during withdrawal. Alcohol has a diuretic (increasing urine secretion) effect by inhibiting production of the anti-diuretic hormone of the posterior However, pituitary. effect this occurs only, as the alcohol blood level rises.

Other effects of ethanol catabolism in the liver cell include inhibition of the tricarboxylic acid cycle and NADPH production.

Many theories to explain the cau-

ses of alcoholism have been propose yet none has gained wide acce tance. A controversial biochemic hypothesis that relates alcohol add ction to opiate (morphine and relate compounds) addiction has been pro posed. Alcohol, by way of its pr mary metabolic product acetaldehy de, competitively inhibits NAD-linke enzyme, aldehyde dehydrogenase an augments the formation of tetrahy dropapaveroline (THP), a benzy tetrahydroisoquinoline. The limite capacity of the brain to oxidiz aldehydes may be of pharmacological importance because it facilitate production of THP in the presence of drugs that inhibit this enzyme.

K.R. NATRAJA

Asstt. Prof. of Chemistr

Presidency Colleg

Madras-60000

Sunflower—an ideal source for oil

SUNFLOWER, a native of Central America, moved to Europe and therefrom to Russia and countries of its neighbourhood. Today Russia produces two-thirds of world's sunflower oil. Yugoslavia, Rumania, Bulgaria, Hungary and Canada produce the rest. It is also grown in other parts of the world.

Sunflower, popularly known as Surajmukhi, is a familiar plant. The plant has been grown in our country for its ornamental attraction for quite sometime. However, varieties suited for oil production have received attention only recently.

According to data available, the average per capita intake of fats and oils in the country during the past three decades has remained stagnant at a level of about 26 gm. (FAO

1967) against a minimum of 60 to 70 gm per capita per day. There fore, there is an urgent need of stepping up oil availability in the country.

Sunflower with its high yield potential, rich oil content, photo insensitive nature of the crop and a short growing period holds promise to overcome or reduce substantially the edible oil shortage in the country (Table 1).

Table 1. Oil content of some major oilseeds (per cent)

Name of the oilseed	Oil conten
Sunflower	45-5
Saflower	3
Soybean	3
Mustard	
Groundnut	35-4
Groundaut	45-5



Fig. 1 (a). Sunflower plant

Russian breeders like V.S. Postooit of the All Union Research Instiite of Oilseeds, Kransodar (Soviet ederation) transformed the original inflower, which came from North merica by reducing the thickness of ne shell and increasing the oil conent from 28% to 50%. Now the tussian breeders are working on arieties with 60 per cent and above il. Sunflower varieties which have een introduced in India for cultiation are Vniimk 8931 (EC 68413), Peredovik (EC 68414), Armavirskij EC 68415), Armaverts (EC 69874) and Sunrise Selection. The oil conent of these varieties is given in able 2.

Table 2. Oil content of exotic sunflower varieties

/arieties	Oil conten	t (per cent)
/niimk-8931 (E	C 68413)	45
eredovik (EC	68414)	45
rmavirakij (E	C 68415)	45
rmaverta (EC	69874)	45
unrise Selectio	n	40

Table 3. Fatty acid content of some major oilseed crops (per cent)

Name of the Oilseed	lodine Number	Poly- unsaturates	Mono-unsaturates		Mono-unsaturates		Saturated Fatty acid
		Linoleic	Linolenic	Oleic Erusic			
1	2	3	4	5	6		
Sunflower	130	68	0	20	12		
Safflower	145	75	0	17	8		
Soybean	135	50	7	28	5		
Mustard	100	15	2	77	6		
Groundnut	84-105	20	71.4	62	12		

Source: Robinson et al. (1958) and Singh (1958)

Quality of sunflower oil

A high quality oil is extracted from the seed. Sunflower oil is particularly favoured by the nutrition conscious people as it has a rich content of linoleic acid (68 per cent). The medical researches have revealed that linoleic acid reduces the amount of cholesterol in the blood and thus prevents blood circulatory troubles. The sunflower seed oil, in addition to arresting the cholesterol level in blood serum, is also known to reduce it further. It is because of this kind of relationship that soft oils such as that of sunflower are recommended as a dietary constituent to patients suffering from artherosclerosis—a physiological disorder of the arteries.

The recent medical researches have shown that increasing cholestero content in cerebral artery and coronary artery results in sudden death Increase in cholesterol content leads to thrombosis in later stages.

Sunflower oil, rich in polyunsaturated fatty acid (PUFA), is ideally suited for manufacturing vegetable ghee. Keeping this in view, Government of India has made it compulsory to blend sunflower oil in vegetable oils at the rate of 7.5 per cent. Sunflower oil can as easily be hydrogenated as groundnut or cotton seed oil. According to Dr. Ragan (1973), sunflower oil does not need hydrogenation as it can be used in liquid form in blending with Vanaspati



Fig. 2(b). Sundower seed

This will keep the nutritional quality ntact.

Sunflower oil has an excellent shelf ife due to near or complete absence of linoleic acid. The smoke point of sunflower oil is high, so loss in rying food is minimum. Sunflower oil may be used as a lubricant for ighting purposes. It has a potential value as a fuel in diesel motors. It is also used in manufacturing paints, arnishes and soap. Since sunflower seed oil can be extracted with simple machinery and know-how, it does not require sophisticated and expensive equipment.

Nutritive value

100 gm of sunflower seed contain he following nutrients:-

70			
rotein		19.8	gm
at (oil)		52.1	**
arbohydrate		17.9	**
alorie		620	
alcium		280 n	ngm
ron		5	
hiamine		0.69	**
Liboflavin		0.20	
liacin	46	4.5	
	COLUMN TO SERVICE STATE OF THE PARTY OF THE	1466	

As compared to other oilseeds unflower is rich in protein and alorie (energy). Sunflower seeds are used for table purposes after lehulling, frying and salting. The eed is salted without dehulling by soiling it under pressure in brine solution and drying it thereafter.

Sunflower seed oil meal contains 10% to 44% high grade protein. Besides being highly digestible (90 per cent), its protein is a rich source of vitamin B-Complex and contains air quantity of phosphorus and calcium (Bricker and Smith, 1951). The meal obtained from kernels is sweet in taste and quality-wise equals or is superior to that of sesame and oybean proteins (Table 4).

It is clear from the table that rom nutritional stand-point there ppears to be no reason why sunlower should not be included in

Table 4. Amino acid content in protein of some major oilseed cakes (amino acid in gm per 16 gm of nitrogen)

101 14 14 14			in terminal to	om decrement	ter an Catal Lang.	4-
Amino acids			Sunflower	Safflower	Soybean	Ground
*********	100	-	5 mini 2 10 0	F 416 AMC	TE 100 ME TE	
Methionine			3.4	3.2	1.1	0.8
Arginine			8.2	8.7	7.0	10.4
Theonine			4.0	4.0	3.9	2.6
Tryptophan			1.3	1.8	1.2	0.9
Valine			5.2	5.1	5.2	3.7
Isoleucine			5.2	4.8	5.8	3.3
Leucine			6.2	7.5	7.6	6.4
Phenylalanine			5.7	8.0	4.8	5.1
Histidine			1.7	1.5	2.5	2.9
Lysine			7.3	2.8	6.6	3.3
4 4 4 4		100		700 8		

the list of protein-rich foods. It is also a good ration for poultry and livestock and can be used as a palatable mixture in baby food and other articles of human consumption.

Sunflower seeds have been used in the treatment of bronchial, laryngeal and pulmonary infections, coug and colds.

> RAJENDRA SIN Soybean Production Offic S.P. & R. 182, Civil lin Bareilly (U.

Sexual parasitism

ERATIOID anglerfishes have nearly one hundred species constituting eleven families. These fishes are deepsea inhabitants found at the depth of five hundred meters, and are distributed in the oceans throughout the world. They have population densities which obviously make reproduction a problem in deep sea. However, they have evolved a typical strategy of male dwarfism and obligatory sexual parasitism. The male attaches to the body of a female in any stage of the latter's life cycle. The male is smaller in size than the female. It is possible for the gigantic female to move freely in water. In the family Ceratidae of the anglerfishes, the males have forwardly directed eyes apparently for search and identification of females of the same species. The male of ceratioid anglerfishes possess a set of pincer

like denticles at the tip of their ja for grasping and holding the fema The attachment is not superfic and is followed by fusion of epid mal tissues which eventually leads the fusion of the circulatory syste so that the male and female blood o interflow. The association is the fore not only physical but phys logical as well. The male partner concerned with the sperm producti while the female, besides produci ova, also provides blood transport nourishment to the male. Such association is unique to these spec of fishes.

In a recent article in Nature (V. 256, July 3, 1975, pp. 39) Dr. T. Pietsch of the Harward Universit UK, has mentioned that the gonad development and sexual maturity

(Continued on page 53

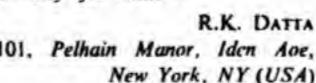
NEWS & NOTES

Basic unit of magnetism detected

N August 14, 1975, The American Institute of Physics and the niversity of California at Berkeley intly announced that a particle presenting the basic unit of magnesm had been observed by a group f physicists. The particle elieved to have left its track on layers f plastic and emulsion hung from a aloon at high altitude in a search or evidence of superheavy elements cosmic rays. The existence of his particle has been suspected for nost of the past century but had

stubbornly eluded detection. If confirmed, the detection of the particle will have a major impact on physics and technology. The reported particle is said to be much heavier than a proton and has a magnetic charge far stronger than the electric charge of an electron. Because of its strong magnetism, the particle would respond readily to an electrical field and thus could be an efficient source of energy. The particle would have a strong charge or pole, rather than two. and thus is called a monopole. The investigative team consisted of Dr. P. Buford Price, Professor of Physics at the Berkeley campus of the University of California, Dr. Edward Shirk, Dr. W. Zack Osborne and Dr. Lawrence S. Pinsky. Drs. Osborne and Pinsky are associated wih the University of Houston. If the particle could be captured and controlled. the investigators said, the applications could be far-reaching. The announcement spoke of such applications as "new medical therapies in the fight against diseases such as cancer, new sources of energy. extremely small and efficient motors and generators, and new particle accelerators of much higher energy than any yet built".

101, Pelhain Manor, Iden Aoe, New York, NY (USA)



INSA award winner-1974 -an interview

of was never interested in zoology," said Dr. M.S. Shankaan laughingly, perhaps at himself. he irony is that he is at present aching zoology at Hindu College, belhi; has a doctorate in zoology nd, on top of it, has won Indian lational Science Academy Award 974 for his original work on oral ontraceptives. Today he is a dediated researcher; in fact, as a result

of the award, he is determined to intensify his research.

Bespectacled, reticent in appearance and articulate while talking, Dr. Shankaran hails from Kerala. He had his schooling and undergraduation in science there, but had his M.Sc. and Ph.D. from Delhi University. Although he wished to take up medicine as a professioneven when he was doing M.Sc. he



M. S. Shankaran

had though! of switching overfinancial constraints forced him continue with pure science. How ever, when he finished M.Sc., I suddenly found himself intereste in zoology. Under Prof M.R.M. Prasad of Zoology Departmen Delhi University. took u he research in endocrinology. In 197 he received the Ph.D. degree, an for some work he had done for h thesis INSA awarded him a meda and Rs. 5000 in cash. (see for h work on Antiestrogens in Medica Notes).

Dr. Shankran has been teachin zoology for the last 2-3 year Though he enjoys teaching, he re gards it to be a 'means' and not a 'end'. It is because, he says, fo one thing, the topics he teaches hav no relevance to his research and secondly, he is not able to pay du attention to research. "That's th reason why Indian scientists g abroad," he laments, "there, there are full-time research posts available in universities which provide no only satisfaction in work but als good emoluments". This doesn mean that Dr. Shankaran wants t go abroad, once for all. In fahe does want to but for some yea only, because "Zoology Department at Delhi University is very we equipped."

DITTP M. SALT

MEDICAL NOTES

Is rice taboo for the diabetic?

T is still widely believed that rice should be totally avoided by a abetic and instead, he should eat heat or ragi. While it is difficult explain the origin of such a lief, it probably goes back to the e-insulin era, that is, the Naunyn eriod, when treatment of diabetes insisted of severe carbohydrate striction and intermittent fasting. owever, with our present underanding of diabetes and in the light experience with rice diets at the iabetes Research Centre, Madras, e feel that the avoidance of rice is ardly justified.

The fallacy of a diabetic changing our to a wheat or a ragi diet as art of the treatment of diabetes ellitus becomes obvious as we ke a look at the food values of ajor cereals.

ajor cereals.

Table 1, shows very little differce between the various cereals in
eir carbohydrate content. The
abetic who changes over to a wheat
a ragi diet and then consumes twice
s normal amount of food under
e firm belief that he is undergoing
eatment' for diabetes is only
ceiving himself. The first step in
e treatment of diabetes by diet
atrol is reduction in the total
lories of food. It is quite imaterial whether one takes rice,
neat or ragi.

It might be thought by some that wheat contains more protein than rice (11.8 gm per cent in wheat compared to 8.5 gm per cent in rice). While this difference itself is not appreciable, Gopalan and his colleagues at the National Institute of Nutrition, Hyderabad, have shown that the protein of rice is superior to that of wheat. Viswanathan of Madras observed that experience with rice diets over a period of 15 years has convinced him that if the total calories are restricted, a rice diet can be used for a diabetic to achieve easier, quicker and better control of diabetes.

Western diabetic diet

In the west, workers are still reluctant to advocate a diet rich in carbohydrate. The typical western diabetic diet consists of about 50% fat and is restricted in carbohydrate content (33%) (Table 2).

In India, in the majority of the population, cereals form bulk of

the diet and constitute the ma source, if not the only source, nutrients. In South India, peo are accustomed to a relativ higher carbohydrate content in food at the expense of proteins. typical South Indian meal of t middle income group is of about 30 calories, which consists of a morni tiffin of iddlies or dosas, rice me in the noon and night and coffee between consisting of the compositi as shown in Tables 3 and 4. T respective percentage of carboli drate, proteins and fat is shown Table 4.

The food of an average Indisis quite rich in carbohydrate the form of rice and wheat as severe restriction in their quantition needs drastic changes in the diet pattern, which is unlikely to adhered to over a long period time. In view of the pattern of fooin our country, many workers fe that a higher carbohydrate content the diet of the diabetics was necessarily and the diet of the diet of the diabetics was necessarily and the diet of the

Table 1. Food values of cereals

Cereal	In gm per 100 gm				
	Carbohydrate	Protein		Fat	
Rice	78.2	8.5		0.5	
Wheat	71.2	11.8		1.5	
Ragi	72.0	7.3		1.3	

Table 2. Typical western diabetic diet

	Gm	Calories	Percentage
Carbohydrate	150	600	33
Protein	75	300	17
Fat	100	900	50
Total calories		1800	

Table 3. Typical south Indian diet-composition

	Gm	Carbohydrate	Protein	Fat	Calories
Cereals	550	440	33	4 2	1910
Pulses	30	18	6	-	96
Oils and fats	40	_		40	360
Root vegetables	50	12	1	_	52
Leafy vegetables	50	3	1	-	16
Milk	300	14	10	11	195
Meat, fish and egg	40	-	7	5	73
Sugar and jaggery	60	60	_	_	240
Fruits	50	15	-	_	60
Total	***	562	58	58	3002
management of the later of the	A CONTRACTOR OF THE PARTY		and the same of the same	A Strade of August Street	and the last

Table 4. Typical south Indian diet-break-up of proximate principles

Gm	Calories	Percentage
562	2248	75
58	232	8
58	522	17
	3002	
	562 58	562 2248 58 232 58 522

Table 5. High carbohydrate-high protein-low fat diet - composition

	Gm	Carbohydrate	Protein	Fat	Calories
reals	175	140	11	1	613
lses	150	90	36	4	540
ls and fats	30	-	-	30	270
afy vegetables	150	8	3	-	44
ilk (skimmed)	600	27	15	-	168
eat and fish	60	_	12	10	138
g white	2 No	s –	26	-	104
otal		265	103	45	1877

Table 6. High carbohydrate-high protein-low fat diet break-up of proximate principles

	Gm	Calories	Percentage
arbohydrate	265	1060	56.4
rotein	103	412	22
at .	45	405	21.6
otal calories	100	1877	M = 11 16 -
The second production of the party of the	-	P. (27.1.)	e -

ary. Patel of K.E,M. Hospital, combay and Vaishnava of the Maulana Azad Medical College, lew Delhi noted the usefulness of iets with a higher content of arbohydrate.

In 1968, Viswanathan reported is results with the high carbohydrate iet that he formulated for diabetics, ith carbohydrates constituting about 0% of the diet. The carbohydrate iven was usually rice. The total alories was calculated at 25-30 alories per kg of ideal body weight. was found, however, that many atients did not have sufficient proin in their diet. The protein conent of the diet was then raised, which esulted in a further reduction in the at content of the diet. While selecting he fat, steps were taken to see that a ood percentage was of the ployunaturated variety.

The protein added was in the form of pulses like bengal gram, green gram and black gram. This helped not only to provide a greater variety of palatable food, but also to achieve easier and better control of diabetes. There was yet another important reason for addition of these pulses. Cochrane and his colleagues in 1956, and Mathur in 1969 from Agra, have shown that bengal gram helps in the prevention of atherosclerosis by reducing serum cholesterol and triglyceride and possibly through some other mechanisms. As is well-known in the diabetic, the atherosclerotic process is accelerated. Hence, in the diet described above, it is felt that addition of bengal gram might help in delaying atherosclerosis and prevent its crippling vascular complications. Gopalan has also stated that the

proteins of cereals and pulses have mutual supplementary effect and the deficiency of one amino acid one one food stuff can be made good to its excess in the other, if both a consumed at the same time. The inakes this diet a well balanced differ diabetics. It may be called restricted calorie, high carbohydrate high protein, low fat diet.

A break up of the high carbohy drate-high protein diet is given i Tables 5 and 6.

Viswanathan reported in 1974 the efficacy of this diet in the treatment of diabetes mellitus. When patient were put on this diet the fasting block sugar was reduced and the glucost tolerance test showed improvement. The following observations have been noted during use of this diet over a long number of years.

- The patients cooperation we more readily obtained, because the pattern of the diet was not change
- The incidence of ketos (diabetic coma) was found to be low
- The control of diabetes was easier and quicker.
- The dose of drug's used was very low.
- The serum levels of cholesters and triglyceride showed a tendent to fall contrary to current belief.
- The incidence of vascular complications was found to be low of follow up of patients on this die Conclusion

There is no such thing as a 'ideal' diabetic diet. Any diet the is restricted in the total number calories, and which is likely to ladhered to by the diabetic throughout his life, and which will not lead any deleterious effects by increase levels of lipids, which are important risk factors in atherosclerosis, must be considered a satisfactory diet for the average diabetic in Indiawho is used to a diet richer in calories and in its fat content, as

rich in carbohydrate and protein ems to be the best diet. The proin is taken preferably in the form pulses like bengal gram or green am. Regarding the carbohydrate intent, there is no difference beteen rice, wheat or ragi. Hence, ere is no need to change from a rice diet, which is the usual diet in our country, to a wheat or a ragi diet.

A. RAMACHANDRAN
M. VISHWANATHAN
Diabetic Research Centre
Madras-600013

Antiestrogens

THE investigations that led to the award of the Science Academy edal for young scientists for the ar 1974, were mainly on the action echanism of a class of chemical mpounds known as 'antiestrogens'. ntiestrogens, in a broad sense, ay be any substance that antagoses the actions of female sexrmone, estrogen. Various steroid rmones, antigonadotropins, antitabolites, antibiotics, ergot alkads, prostaglandins and many other bstances are inhibitory to the action estrogens and come into the catary of antiestrogens. However, the e antiestrogens are only those comunds which interfere with the meanisms of subcellular action of a rmone like estradiol-178.

Antiestrogens are a class of comunds of considerable biological d clinical importance. They are ed in the induction of ovulation in ovulatory women, in the treatent of endocrine disorders like ecocious puberty and breast cancer, d are also used in the elucidation specific steps in the action echanism of steroidal estrogens. sides, some of the nonsteroidal tiestrogens inhibit various estron dependent events in the female nital tract during early pregnancy resulting in the failure of implantion of ova. These compounds fer another possibility, of their use as 'anti-implantation' agents for post-coital contraception in human female.

Detailed investigations on the mode of action of antiestrogens indicate that they are competitive inhibitors of estrogens' action in estrogen sensitive target organs like uterus, cervix and vagina. These studies conducted in a new experimental setup where rats were ovariectomised on day 3 post-coitum, and were administered 4 mg of progesterone per rat per day on the day of ovariectomy and thereafter till the termination of the experiment. In this condition the fertilised ova enter the uterus as blastocysts, as in the normal pregnancy. However, the implantation of these blastocysts to the uterus is delayed until the rats are treated with a minute dose of an estrogen. The 'delayed implantation' in the rat caused by this procedure, is comparable to the period of preimplantation pregnancy and is an ideal experimental design for the study of mechnanisms of estrogen-antiestrogen interaction.

A variety of antiestrogens were studied in terms of their responses in the various estrogen sensitive target organs with respect to many biochemical parameters of estrogen action—starting from the early uptake of the hormone to the target organ to the gross morphological

changes in the target tissue. The studies on the mode of action of no steroidal antiestrogens in rats show that the biological properties antiestrogens vary with reference a number of factors, namely: (the type of antiestrogen, (b) t dose of the antiestrogen admini tered, (c) the responsiveness of a estrogen sensitive parameter, (d) ti type of target organ studied, and (the time sequence of action of antie trogens. Once antiestrogens occup the 'estrogen-receptors' in the targ cell, they prevent estrogens from r aching these sites thereby preventing gene-transcription and translatio and the subsequent biological action

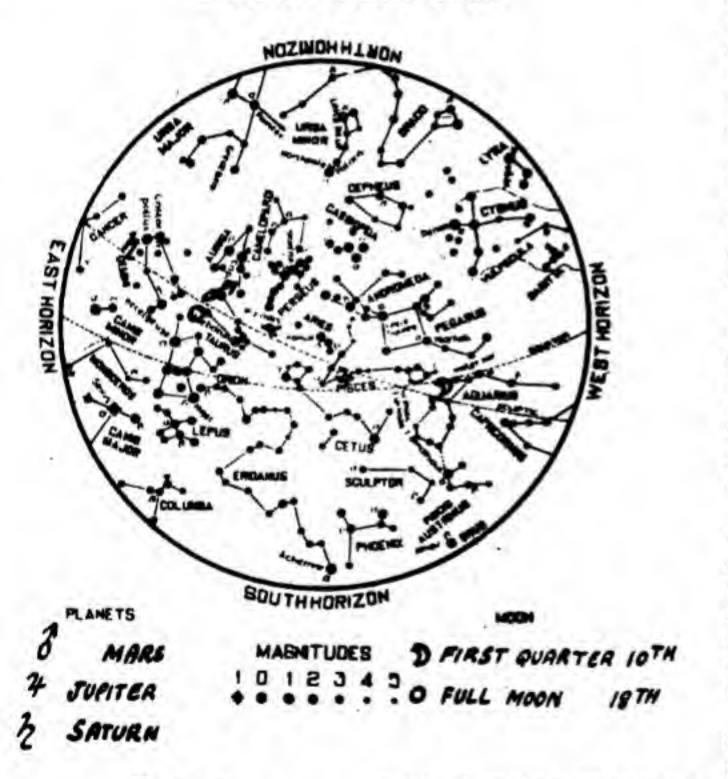
The renewed interest in the stud of antiestrogens is mainly due their possible use as post-coital coi traceptives for the control of fert lity in human. Antiestrogens, who administered to laboratory anima (rats and mice) during 1-4 day of normal pregnancy, inhibit ovu Detailed investig implantation. tions showed that antiestrogens who administered during the preimplan tation period of pregnancy inhib various estrogen-sensitive physiole gical and biochemical events in th uterus altering the uterine milie in such a way as to inhib implantation of blastocysts. Th anti-implantation action of antie trogens have been demonstrated i various species of mammals.

One of the pre-requisites for a ideal post-coital contraceptive for human use may be its prolonged act vity. No doubt a drug with prolonged activity after a single administration will obviate the problems of repeated administrations, and attendent practical difficulties in the drug delivery and will be more acceptable as a contraceptive agent. Studies it rats during delayed implantation indicate that if the initial dose of the antiestrogen is increased by 10 time it is possible to retain the antiestrogenic activity of the compound for

(Continued on page 538

PLANETS AND THEIR POSITIONS

DECEMBER 1975



The moon

New moon occurs on 3rd at 6-20 a.m. and full moon on 18th at 8-10 p.m. I.S.T. The moon passes about five degrees north of Jupiter on 13th, five and a half degrees south of Mars

on 18th, about five degrees south of Saturn on 21st and two degrees south of Venus on 29th. The lunar crescent becomes first visible after the new moon day in the evening of 4th. The moon is at apogee or farthest

from the earth on 12th and at perig or nearest to it on 26th. The sun at the winter solstice on 22nd.

The planets

Mercury (Budha) is too near the sun to be visible during the first three quarters of the month. Thereafte it reappears as an evening star and sets about an hour after sunse It moves from Scorpio (Vrischika to Capricorn (Makara) through Sag ttarius (Dhanus). Its visual magn tude is about — 0.6.

Venus (Sukra), a morning starises about three hours after local midnight during the month. moves from Virgo (Kanya) to Scorpi (Vrischika) through Libra (Tula lts visual magnitude is about -3.

Mars (Mangala) rises at about sunrise sunset and sets at about sunrise during the month, being at opposition with the sun on 15th. It nearest to Earth on 9th. It move from Gemini (Mithuna) to Tauru (Vrisha) by retrograde motion. It visual magnitude is about -1.6.

Jupiter (Brihaspati), visible in the eastern sky in the evening, sets about one and a half hours after local midnight during the first half of the month and about half an hour after it during the second half. It becomes direct on 10th. It is in Pisces (Mina). It visual magnitude is about -2.2.

Saturn (Sani) rises about three hours after sunset during the first half of the month and about two hours after it during the second half It is in Cancer (Karkata). Its visual magnitude is about +0.1.

(Source: Nautical Almanac Unit of the Meteorological Office, Alipore Calcutta-27).

SCIENCE FOR THE YOUNG

Meeting future energy demands

E NERGY provides us with a capa-city to do useful work. For loing anything like cooking of food r travelling from one place to nother, we need the help of energy. nergy has generally been drawn from hree types of sources: fossil fuels remains of past organisms lying for nillions of years underneath earth's urface)—coal, natural gas and oil; iological sources-wood, cattle dung nd vegetable wastes; and electricity enerated from hydro, nuclear and ermal resources. Of these, from hichever source or in whatever rm we may obtain energy, it in always be converted into more seful and easy-to-use forms using rious mechanical devices.

Various sources of energy in India ave so far failed to meet the full quirements of both the agricultural nd the industrial sectors. This ortage has recently got aggravated rther because of a four-fold increase the international price of crude I. To take the country out of the esent energy crisis, we need to crease the yield and production the current sources. As our ocks of fossil fuels are depleting a fast rate and as our energy quirements in the future are bound increase with increase in human pulation and with improved living andards, we would have to take the help of other energy sources as well.

But before doing so, we would have
to assess the potentialities of the
different sources and would have
to solve many related scientific and
technical problems.

Here we discuss in brief the sources whose yields and productions
can be increased and the ones which
can be or are being tapped for meeting
our future energy demands. A bulk
of our energy requirements in the
distant future would be met by fusion
reactors, though the current sources
would keep on playing their role on
a reduced scale. Use of non-conventional sources like sun, wind, seatides, etc., would increase immensely.

Current sources

Coal. Total known reserves of coal in India are 83 billion tonnes and our average annual production of coal is only 70 million tonnes. This production rate can be increased with improved mining technology. With increased coal production, more thermal-power stations may be set up, while for other convenient uses, oil and gas may be produced from coal by employing various coal gasification techniques.

Oil. Our total known reserves of oil are 130 million tonnes. Our present annual consumption of oil is 23 million tonnes, out of which

Generation of electricity

In all power producing system it is the generator which produce electricity. In big generators, number of electro-magnets attack ed to a shaft are made to rota continually inside a system of coi with the help of huge turbine Rotation of magnets causes movement of electrons in coil which is a flow of electric curren The turbines are turned with th force of water in hydro-electr stations and with steam pressur in thermal and nuclear power plants. In thermal power station source of heat for producing steam is coil or oil; in nuclear power stations, it is the controlled nucles reaction. On similar lines, tu bines in tidal power stations would rotate with the force of water an with the force of fast movin winds in wind mills. Stear pressure would be utilised to tur the turbines in solar and geo thermal power stations.

only 8 million tonnes is extracted from Indian sources. This rate is extraction can be enhanced and, with improved exploration techniques, new oilfields may be located. The recent find of oil at Bombay High mas bridge to some extent the gap be ween our rate of production an consumption.

Cattle dung. Since about 50 per cer of the energy consumed by India masses is biological in nature, a fer per cent increase in yield from the sources can make its impact felt eve in the near future. Gobar gas plants based on fermentation of organisms wastes in the absence of air, an which is in some use now, increase the heating efficiency of the cattering by about 20 per cer and produce an organic manual

which is about 43 per cent better than he dry cattle dung itself. This manure an reduce pressure on naphtha-based ertilisers. Gobar gas, a mixture of methane, carbon dioxide and minute quantities of other gases, is obviously more cleaner fuel than the dry lung itself. Only about 6500 gobar gas plants have been installed so far, nerease in their installation rate may go a long way in meeting our tural energy needs.

Hydro-electricity. The total elecric power which can be gainfully enerated from our all water resources n the country is 41,000 MW (1MW-0" watts), of which only 9000 AW is being generated at present. hough this source of electricity at imes is somewhat undependable ecause of erratic monsoons and less ainfall in catchment areas, yet the otential of this source is tremendous. of the currently used sources. his is the only source which goes vaste if not fully exploited. Yield rom this source can be more effecively used by decreasing transmission osses which amount to about 20 er cent at present.

Thermal power. When electricity generated by burning fossil fuels usually coal), the maximum efficiency of conversion from heat energy to lectricity reached is about 40 per cent. The remaining gets lost due to radiation and other factors. This efficiency may be pushed to about 55 per cent by using MHD (magneto-hydrodynamic) generators which are in the evelopment stage at present.

Nuclear power. Electricity from his source in the country is being enerated using the fission of both atural and enriched uranium. Natural uranium contains only 0.7 per ent fissible Uranium-235, the rest is ertile Uranium-238. Enriched uranium contains more than 0.7 per ent Uranium-235). With the known tranium deposits and present reactor echnology, our generating capacity

of electric power from this source can be 5000 MW, of whiel, only 600 MW is being utilised at present. Our reactors, alongwith producing electricity, produce some fissionable Plutonium-239 from absorption of fast neutrons by Cranium-238. Since our deposits of uranium are rather limited, attempts are being made to develop fast-breeder reactors which can use Plutonium-239 as a fuel.

Chemical energy. I nergy of chemical reactions from cells and hatteries is used mainly for transportation purposes. This energy may be used on a much larger scale for the running of light transportation vehicles and for electrification of small and remote villages using advanced fuel cells. In a fuel cell electricity is produced from a chemical reaction simply due to a rearrangement of electrons in the outer shells of the atoms. Cells which have received the maximum attention are the hydrogen-oxygen cells. They are based on chemicals which offer an easy supply of these gases. When hydrogen and oxygen are allowed to mix in the presence of a catalytic agent, water is formed alongwith the appearance of heat and electrical energy. A typical hydrogen-oxygen fuel cell used in Apollo space missions produced power between 560 to 1420 watts with a voltage range of 27 to 31 volts.

Non-conventional sources

Wind energy. High wind velocities in coastal and hilly regions may be used to run wind mills for electricity generation and pumping water for irrigation purposes. This source can, however, give only intermittent energy, because wind velocities do not remain constant throughout the year or even throughout the day.

Geo-thermal energy. Heat of the earth available in the form of steam under pressure from some wells may be used to generate electricity. First step in this direction has recently

Nuclear terms explained

If a neutron enters the nucleu of an atom and the nucleus break into two approximately equal part releasing two or three fast-moving neutrons, a fission is said to occur The mass difference between the initial and the product component appears as energy. The amount of energy liberated is given by Linstein's famous mass-energy relationship I mes. The out going neutrons cause further fissions, enabling the reaction to continue like a chain. A device in which such a reaction is initiated, maintained and controlled is called a nuclear reactor, and the material which undergoes fission (by neutrons of all energies) is called fissile. Materials which do not undergo fission easily, but may be made fissile by bombardment with fast moving neutrons (neutrons of energy greater than 100,000 electron-volts) are called fertile. Reactors which produce more fuel (fissionable material) than they consume are called breeder reactors, and the ones which breed more fuel, and operate primarily with fast neutrons are ternied fastbreeder reactors. reverse process to fission, in which two or three smaller nuclei combine to form a bigger one, is called fusion. The release of energy in fusion is based on the same principle as in fission.

been taken by planning a 1 MV power plant in the Puga valley.

Solar energy. Sun is a trement dous source of energy which give heat to earth at the rate of 600 calor ries/cm²/day. This energy can be made use of for a variety of purpose like heating water, keeping house warm in winter, generating electricity etc. The scientific principle involved utilising this energy is very mple, in that we simply need a ollector-cum-reflector of sun's rays concentrate them on the object be heated. Once sun's energy has een collected in the form of heat, can be converted into any useful orm using various mechanical evices. Unluckily, technologists ave so far not succeeded much in esigning instruments which can tilise this energy on a large scale. ntermittent nature of sunlight has so made the use of this energy uite difficult. It is, however, lought that in the long run sun ould be one of our major sources f energy.

Tidal energy. In coastal areas there the tidal range is high, sea after may be collected in a basin uring a high tide and on its release trough turbines at low-tide electrity may be generated. The power om such a plant is, however, ependent on the tidal coefficient and available at variable hours during the course of a month.

Sewage gas/Garbage energy. In big ties where underground facilities ext, sewage gas—a mixture of mainly tethane and carbon-dioxide—may be collected. Out of this mixture, tethane may be separated out, ompressed and filled in cylinders, his may then be used for heating urposes. A considerable amount of nergy in the form of heat and agricularal manure may also be obtained from urban trash, which at present discharged in the environment esulting in pollution and health azards.

eveloping sources

MHD generators. In these geneators, electricity is generated by assing a hot electrically conducting lasma in a gaseous or molten state

through a strong magnetic field (i.e., in these, the copper coils of the usual generators are replaced by a hot flowing plasma). These generators work on the principle of Faraday's laws of electro-magnetic induction. The power output from such generators is dependent mainly on the electrical conductivity and the velocity of the flowing plasma, as well as on the strength of the magnetic field. Efforts of researchers are at present directed towards achieving larger output from such generators. It is hoped that such generators would be able to supply power on a commercial scale in about a decade from now.

Fast-breeder reactors. Attempts are being made to develop fastbreeder reactors in India in two stages. In the first stage, Plutonium-239 would be used as a fuel, and this would be covered with either Uranium-238 or with Thorium-232 as a blanket. In the first case, more Plutonium-239 would be bred than consumed, while in the second case fissionable Uranium-233 would be produced. In the second stage, fissile Uranium-233 would be used as fuel, and Thorium-232 as a blanket. This would breed more Uranium-233 than burnt. Since we have the largest reserves of Thorium-232 in the world. thorium-based fast-breeder reactors have a big potential for us It is hoped, fast-breeder reactors would become operational in India in a few decades.

reactors. Since even nuclear power agencies face the problem of depletion of nuclear fuels, sources, scientists have been looking for a couple of years for those sources of energy which may promise a virtually unlimited supply for times to come. One of these is controlled thermo-nuclear fusion. Important fusion reactions on which work is going on are between

deuterium-deuterium and deuterium tritium (both heavy isotopes hydrogen). Deuterium is availab in almost inexhaustible quantities oceans in the form of heavy water and may be separated out at relative low cost. For the fusion reaction undergo, one needs to confine t combining nuclei for sometim (usually a fraction of a second) sufficiently high temperatures (gen rally greater than 10° K) under ve high pressures (greater than 10 atm.). Since this is an extr mely difficult process, attempts a being made to achieve it with the use of powerful laser beams. It hoped, researchers would be ab to solve various scientific ar technical difficulties within a decad or two, and power plants based of laser fusion would become opera turn of the ional by the century.

Future energy

In the immediate future or energy requirements can be m simply by increasing the yields ar searching for new source Import of crude oil may be lowere by making full use of our hydr resources and by increasing or dependence on coal, even if it mean transforming some of our oil-base industries to a coal base. In the intermediate future (beginning abo 2000 A.D.) when the enhanced us of coal would start posing enormor transportation problems, it is hope that our technological advance would enable us to derive enoug power from solar energy and fas breeder reactors. In the distant future, it appears, nuclear power would become a major source of electric generation and would me the bulk of our energy demands.

> NARESH KUMA Physics Deptt., Hindu Colleg Delhi-11000

How fluorescent lamp works

COST is the outstanding quality of fluorescent lamp. Now this lighted device is being preferred to an extric lamp.

Three parts make a fluorescent mp: the fluorescent tube. the oke and the starter. The fluorescent tube produces brilliant light the the assistance of choke and arter. The choke limits undesible voltage or current harmful to e tube. The function of the starter to provide an appropriate voltage ross the tube at the right moment.

The fluorescent tube is a long cyiderical glass tube coated inside th a phosphor (chemicals, e.g., ne silicate, cadmium silicate or leium tungstate). A phosphor is a emical that exhibits the property fluorescence. In other words, hen a radiation of some wavelength rikes a phosphor, it absorbs the diation energy and emits it at the me instant but with a longer wavength. The out-coming altered raation lasts as long as the incident diation continues to strike the nosphor. The moment it is cutf, the out-coming radiation stops. The phosphor-coated fluorescent be contains mercury vapours and me minute traces of argon at a ry low pressure. Mercury vaours release ultraviolet rays when ombarded by fast-moving electrons avelling from negative to positive ectrode of the fluorescent tube. he easily-ionisable argon is present initiate this process. The elecodes are made of tungsten metal overed with an electron-emissive

The starter is a glow-switch—an gon filled tube sealed with two elecodes. The electrodes can be interonnected only by heat. If the space side the tube becomes hot, the expansion of bimetallic contact present between the electrodes takes place (see figure), ultimately bridging the gap. When the space cools down, the bimetallic contact between the two electrodes breaks owing to contraction.

In a fluorescent lamp, all the three components are arranged in a special type of circuit known as 'pre-heat circuit'. The choke is in series with the electrodes of fluorescent tube, whereas the starter is parallel to it.

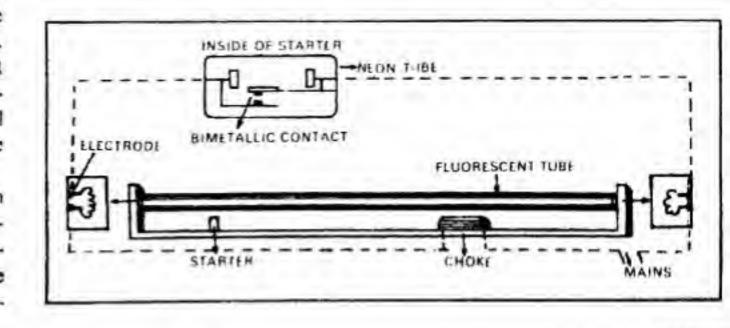
When switch is flicked 'on', a high voltage acts across the electrodes of the tube and those of the starter The voltage across the electrodes of the starter ionises argon easily starter, therefore, allows a small current to push through it. The voltage across the fluorescent tube is unable to ionise the enclosed mercury vapours. It is because of two reasons first, that the mercury vapours are not easily ionisable, and secondly, there is a large gap between the electrodes. So, the minute current that flows through the starter heats the electrodes of the fluorescent tube, knocking off electrons from the electron-emissive material. The electrons accumulate about the electrodes of the fluorescent tube.

Consider now the subsequent changes in the starter and, hence, in the circuit. The flow of current through the starter heats the space inside is leading to the linkage of the two opposite electrodes. No soone this happens than the whole voltage gets applied across the already heated electrodes of the fluorescent tube. The electrons that were present around the electrodes get instantane ously attracted to the electrodes of opposite polarity.

As there is no gaseous conduction in the starter tube, the enclosed space cools down in due course, breaking the bimetallie contact. The ins tant this occurs, full choke voltage acts across the electrodes of the fluorescent tube which, in turn accelerates the moving electrons The velocity of the electrons is in creased so much as to release shor ultraviolet rays by collisions with mercury vapours. Wherever, the radiation strikes the phosphor coat ing of the tube, fluorescence take place with the subsequent release o brilliant white light in the visible region of the spectrum.

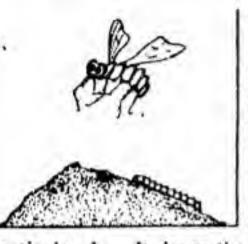
Now when the electrodes have no been heated by any outside mean (due to the disconnection of starter) the electrons are knecked off the electrodes by the bombardment of mercury ions. These developments from the instant the circuit is activised to the production of light, take place within a second or two.

The light from a fluorescent tube depends on the number of electrons (Continued on page 567



aterial.

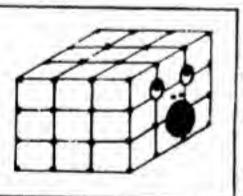
Believe it or not



THE wasp, Sphex, is a one track minded animal and likes to stick to one routine for life! During egglaying season Sphex behaves in a very peculiar way. It would kill a caterpillar and drag it to its burrow which it had prepared previously

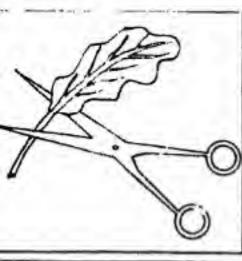
neticulously. It drops the caterpillar at the door, goes nside the burrow to check if everything is alright inside. Then it comes out and takes the caterpillar inside.

However, just as it goes inside the burrow, you remove the caterpillar away at a distance. It will come out and search for the insect. The wasp will drag the insect to the burrow gate, and will go inside the burrow gain to check. The caterpillar is taken in only after everything is alright inside. However, if you drag tway the insect again, the wasp will repeat the whole process. Just like a programmed computer, the wasp will drag the insect, leave it at the door, go inside and then will come out to take the caterpillar in. You can remove the insect as many times as you care. The wasp will not falter in its routine!

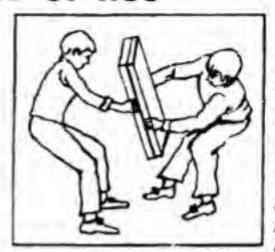


A cries when subjected to a force. This is the well-known phenomenon of Tin cry and is caused by the process of slip. When the crystal is subjected to plastic deformation, the crystal is

deformed. This deformation occurs by a gliding or a shearing action on certain planes within the crystal and a scalled a slip process. During this slip process the cliding or shearing occurs by distinct movement on clanes. This movement is often heard, particularly, in the case of Tin crystals, and is termed as Tin cry.



SPINACH dies if not trimmed regularly. The reproductive parts of spinach must be trimmed and removed regularly in order to avoid death of the plant. In fact, aging and eventual death of spinach can be postponed indefinitely in this manner.



If two plates of ordinate glass which have be polished and ground perfetly flat are brought togethe these will stick to each other as if glued together. It unpolished and ungrouglass plates will not stick all. This happens due to the force of cohesion—the force

with which like atoms attract each other. Within given solid these forces are very large and that is w we cannot tear the solids apart, at least, easily.

When ordinary glass plates are brought in conta with each other, there are only a few points of conta between the two plates due to irregularities in to surfaces of the plates. The force of cohesion is the small and the two plates do not stick to each other On the other hand, when these plates are clean, possible and ground flat, the points of contact increase tremendously. The cohesive force becomes very lar and the plates stick together. Thus, two high gragauge blocks will stick and cohere if brought in contact. These can only be taken apart with considerate force.



year. Our nose and e get stiffer each year. O chest becomes more rigi Our weight loss at 90 about 13.5 kg. Our air inta

60, we lose about 1.3 c

Our brain loses weight ea

S we grow old: O

height decreases -

at 75 is only half of what we inhale at the age of 20.



THE children of shot parents are usually to ler than either of them. On the other hand, the children of tall parents are short than either of the parents than either of the parents. This is known as the Law Filial Regression and we given by Sir F. Galton, holds remarkably well most of the cases.

M.H. KHA Pihani Ultra-Pure Materials Corp A-128, Vivek Vihar, Shahdara, Del

SCIENCE INDUSTRY

Sodar-acoustic waves that detect atmospheric variations

CIENTISTS of the mineteenth century attributed the long peristing echo of a siren heard on some oggy day to the flocculent nature of he atmosphere. In 1946, acoustic choes of an unexpected high intensity rom the lower atmosphere were first etected. In the mid 1960's the potenal use of the acoustic scattered inensity from the atmospheric flucuations of the wind velocity and emperature was rediscovered. It howed that acoustic echoes from tmospheric inhomogeneities can e readily obtained and studied to ive information about atmospheric arameters.

The sound beam on passing from quiescent medium into a region of urbulence is scattered in all direcions with random fluctuations in implitude, phase and frequency of he wave. The phenomenon results due to interaction of the velocity field of the acoustic waves with the velocity field (of the turbulence and the random spatial) and temporal variations in the physical properties of the medium. Scattering in the backward direction, i.e., at the scattering angle of 180 degrees, is only due to inhomogeneities in temperature, while in any other direction both thermal and wind fluctuations contribute to scattering of acoustic waves. A monostatic or co-located system thus gives information of the thermal inhomogeneities in the atmosphere while Doppler shift measurements

give information about the wind parameter.

The device for detection and ranging of atmosphere inhomogeneities using sound waves have been given the name of sodar in a manner analogous to radar. A pulsed narrow beam of sound waves is transmitted into the atmosphere where it encounatmospheric inhomogeneitie and suffers partial reflection. The reflected waves are received either by the same transducer (monostatic) or by one or more other transducers (bistatic and multistatic). The delay time and intensity are measured with each echo sean in the form of intensity modulation on a sweep recorder of the facsimile type displaying height range versus time pictures, while the shift in the carrier frequency is detected by a suitable Doppler system.

Sodar essentially locates and measures the intensity of thermal and velocity inhomogeneities

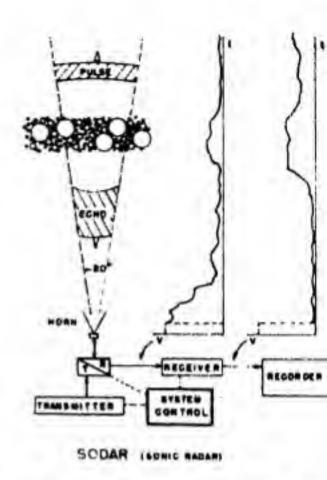


Fig. 1 The monostatic setup for sodar

can be used to infer and determi atmospheric processes and histo-The technique can provide use and continuous measurements of t state of the boundary layer mete rology of the lower atmosphe under clear, cloudy and fog conditions a study which can useful for communication, aviation and air pollution situations. fact, it is now being realised th many cases of short landing a missed approaches leading sometim to fatal crashes can be the result strong wind shear or ducting, et within the first few hundred mete above ground. There paramete can be detected and measured inc pensively with the help of sod facility.

The range of sodar is genera about a kilometer but can be e atmosphere an information which tended up to 10 km. The parameter

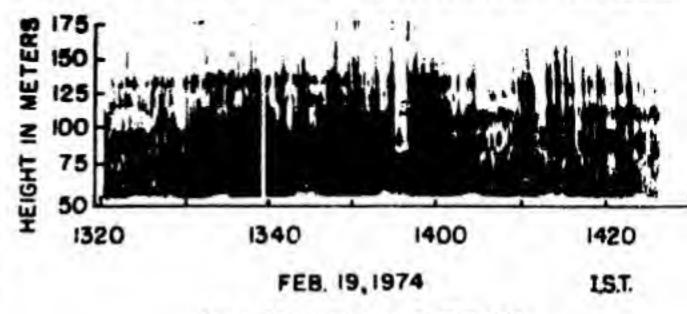


Fig. 2 Laminated structure during night



Fig. 3. Thermal plume structure during day

at most frequently influence the sults in a sodar are the meteorolocal conditions, location (urban or ral), antenna characteristics (like in, beam width and side lobe supession), carrier frequency and ilse acoustic power, etc. The innsity of the sound waves, besides ing attenuated by the path bending nd stray scattering, is inversely oportional to the square of the stance. Because the ambient noise asks the received signal, the latter as always to be higher than the ament noise. The interfering sound ources also limit the usability of the dar. It is not possible to operate e system in the near vicinity of ntilation fans and other noisy uipment and under conditions of verflying aircraft. high winds nd rain or snowfall. To extend the nge, it is necessary to use a more tense source and combat the ament noise as far as possible.

A medium power co-located souner system upto an altitude of 200 m sing a cross-array, as the transmitr, and a paraboloidal bowl with icrophone at its focus, as the receier, was established at National Physical Laboratory, New Delhi in early 1972. The recording was made on a photographic film from the C-scan display on an oscilloscope. This back scattering sodar system in the monostatic mode is now capable of probing the thermal structure of the

lower atmosphere upto an altitude 350 metres.

Facsimile records obtained duri the course of the experiments ha clearly shown the typical stratifi laminated structures formed during night of radiative cooling; thern plume structure formed on a cle bright sunny day and the tempo variations; and instablities and turb lence structure of the lower atmo phere throughout the day. The observations have aroused consideration rable interest, not only in defence b also in the department of meteorolo and civil aviation, because of the potential importance in predicti the formation of ducts and the dev lopment of wind shear in the low atmosphere. Further work to e tend the range of probing to o kilometer and to create the facili of acoustic Doppler sodar is und progress.

> S.P. SING Scientist, N.P. Hillside roa New Delhi-1100

Technology developed for pine needles

THE Regional Research Labo-Jammu, ratory (RRL), has developed know how for the utilisation of huge quantities of pine needles produced in forests of Jammu and Kashmir (J&K) and Himachal Pradesh (HP). The pine needles are the leaves of pine trees and are shed off annually. The annual turnover of these needles amount to nearly 2.7 million tonnes from the states of J&K and HP. The estimated average of fallen leaves per hectare per year amounts

to a tonne. The leaves are present not being used for any commerci purpose and, therefore, form pile of leaves which gradually decompose and mix in soil. In approachab forests of the two states alone, collection of needles to the extent conly 5 per cent of the annual fall warmount to 1,35,000 tonnes (75,00 tonnes in J & K and 60,000 in HP

The technology developed for the utilisation of this natural wealt which until now is untapped will be definitely useful in terms of economy

railability of new products and apployment opportunity to people. The process for the utilisation of medles will help make two very aportant materials, i.e., fibre board sitable for making boxes; and pine ool for stuffing of mattresses, ashions, furnitures, etc., and packing ockery, glassware and other breakble articles.

The technology for making fibre simple and economical. This consts of a softening treatment of eedles followed by defibration. The ulp thus formed is converted into a neet or mat and compressed in a ydraulic press. The output of processed product is 50 to 60 per cent epending upon the quality of raw naterial. The fibre board formed hows considerable strength (modulus

of rupture 225-280 kg/cm², tensile strength 125-150 kg/cm²). The board can be treated for water proofing. The water proof fibre board is suitable for fruit transport. The J & K and HP being the major apple producing areas of our country require a large number of packing boxes annually. The requirements of J & K above is about 25 lakhs boxes and that of HP about 86 lakhs annually. The packing boxes designed by the RRL can withstand a static load of one tonne when fully packed.

The estimated capacity of 2 tonnes capacity plant is 850 packing cases a day. For the reasons of economy the unit should be set up at site, where raw materials are easily available. The capital investment required is Rs 10 lakhs with annual profit

of Rs. 216 lakhs. The cost o production of fibre board is estimated to be about 32 paisa per sq. ft. and that of a packing box of 30 is capacity Rs. 4 80 1th among requirement of needles by a 2 time. capacity plant is 960 tonnes per year The know how for pure wood me nedy softening treatment of needle-follow ed by separation of fibre. The firm and machinery required for the purpose are indigenously available The estimated rost at production of pine wood is about 100, 800 per tonne and a plant of one time; per day capacity will cost about Rs 2 St lakhs. The know how is available for sale with the regional Research Laboratory, Canal Road, Jammu Tawi

ZAKA IMAK

PRAWNS (Continued from page 532)

conomics and conclusion

The economics of shrimp culture lepends upon the balance between fort of production and the market value of the product. In Japan, with all the technological advancement and success achieved in shrimp culture, the price is not less than \$ 6/kg. The cultured shrimp has to face further competition in the market with the natural production. However, in lapan there is a large local demand and preference is given to cultured shrimps for the popular dish 'Tempura' in which only living prawns are used for immediate cooking.

In countries like India, cultured shrimps will not face any problem as much of the product will be exported. However, to make the business profitable the final product should be cheap. This can be achieved by introducing cheap supplementary food. The food conversion efficiency in shrimps is possibly greater in tropical waters. The intensive shrimp culture in India will be a highly promising proposition to earn more foreign exchange, to meet our local food requirements and to provide our people with more employment opportunities.

Further reading

- H. and Melarhey, Willey O.

 Aquaculture, the farming and
 husbandry of fresh water and
 marine organisms, Wiley Inter
 science, A Division of John
 Wiley & Sons, Inc., U.S.A.
- Pillay, T.V.R. (Ed.), Coastal aquaculture in the Indo-Pacific Region Fishery Resource Division, Dept of Fisheries, FAO, Rome, Italy Fishing News Books Ltd.
- Prawn Fisheries of India, Bulletin No. 14, Central Marine Fisherie Res. Institute, August 1969.

SCIENCE FOR THE YOUNG (Continued from page 563)

when the choke voltage acts across the electrodes of the fluorescent tube. This is because they are the electrons which collide with mercury to release the required ultraviolet light

Suppose electrons are not produced in an appreciable amount at that moment for producing the needed arc, no illumination would follow. The whole operation then restarts. That's why fluorescent lamp is sometimes seen flickering in the beginning because of the repetition of the above process. Once light is emitted the starter, which till then played a vita role, becomes an inactive element the circuit.

DILIP M. SAL

BOOK REVIEWS

DVANCED PRACTICAL ORGA-IC CHEMISTRY by J.L. Norula, Julian Chand and Sons, Amir Chandu Marg (Nai Sarak), Delhi-6, Pp. 380, 48. 9.00.

ORGANIC chemistry is a rapidly expanding subject and it is ifficult for a single organic chemist be familiar with the recent developnents in the field. Practical organic hemistry is more difficult as one as to read theory as well as instrunentation. The material available n practical organic chemistry so ar is stereotype and normally fails provide a clear understanding f the subject to the students. The esult is that the student lacks confience, necessary aptitude ompetence for practical work which extremely necessary to understand he theory.

The book under review is an ttempt to bridge the gap and ummerise in a single volume the aboratory course for the underraduate (Hons.) and postgraduate tudents. The author, who has been teacher of organic chemistry or a long time, has tried to provide eliable survey of the techniques and nethods involved in purification, haracterisation, identification, estination and synthesis of organic compounds. The book aims to levelop in a budding chemist a clear inderstanding of reaction and ynthesis which will enable him to elect reasonable conditions for any ransformation he may wish to carry out in future.

The subject matter of the book is divided into six parts. The Part I deals with the techniques of organic aboratory processes. Determination of various physical constants of

organic compounds and the importance of these constants in characterisation of organic compounds have been discussed in Part II, while Part III contains reactions of functional groups and formation of derivatives of the various classes of organic compounds. Quantitative analysis is the subject matter of Part IV. Semi-micro methods of quantitative organic analysis applied to the estimation of the constituent elements in organic compounds, the functional group or groups present and the determination of molecular weights of organic compounds have been included in this part. Part V contains preparations of the different organic compounds whereas the last, part IV, deals with various types of instruments and the principles involved in the organic analyses.

In addition to this, there are references for advanced reading. In appendix, densities and boiling points of common liquid organic compounds, synthetic sequences and preparation of common laboratory reagents are given. The printing, layout and getup of the book is satisfactory. Had there been tests for elements and functional groups at one place in a tabular form, so that a student could consult and do his practical work simultaneously, the book would have been more useful. Anyway, the book will indeed be well accepted by the readers and fulfil the aim it is intended for.

PRADEEP KUMAR

THE INVISIBLE UNIVERSE: THE STORY OF RADIO ASTRONOMY by Gerrit L. Verschuur, Springer Verlag, Heidelberger Platz 3, D-1000, Berlin 33, Germany, Pp. 192, DM 15, 40 (US \$ 6.30)

THIS is one of the finest, most lucidly written non-mathematical texts on radio astronomy which this reviewer has had the privilege of studying. Written by a member of the Fiske Planetarium, Dept. of Astro-geophysics of the University

of Colorado, it presents in less the 200 pages a penetrating picture the cosmic space around us which abound in planets, exploding star galaxies, quasars and pulsars. The astral objects, their movements as their composition, are difficult comprehend normally and require fairly high knowledge of physics at astronomy. The author, however has presented a story in simple as succinct language with considerab accuracy that it becomes a pleasure read and follow what happens the universe around us. The who tale is about a science born in the mi 20th century and now beginning flourish with dramatic discoveri of objects and phenomena unknow a decade ago.

This science of radio astronom which is throwing out something no and unknown virtually every da is quite young and nascent as born out by a number of observation Thus it was only in the first third this century that man realised that t Milky Way was but one of man galaxies in the universe and that the space between the stars was f from being empty. In fact, the pr sence of hydrogen gas between the stars was revealed by this science on as late as 1951, while quasars we discovered, in 1963, pulsars in 19 and the first triatomic molecules space in 1968.

The author explains the bas elements of radio signals from space how they are picked up, the natu of radio telescopes and their gener functions. In fact the latter aspe forms the frameweork on which th work is based. Here the auth weaves his story from the ear work of Karl Jansky in 1933 as the radio amateur or 'ham', Gro Reber of Illinois, to the setting t of the famous radio telescope Jodrell Bank in Manchester and the U.S. National Radio Astronom Observatory's high-accuracy stee in Green Ban able telescope West Virginia.

Beginning with the radio mappin of the sun and an explanation of the rious solar phenomena, the author asses on to the planets stressing the naracteristics of Jupiter and Venus nd explaining the several processes at are operative in the solar sysm such as those in the Milky Way. he Sun is but one of many hunreds of thousands of millions of ars in the Milky Way Galaxy, and ere are thousands of millions of alaxies in the universe. The centre of e Milky Way lies about 30,000 light ears (283,800 million million km) way in the direction of the consteltion Sagittarius, but is invisible to ptical telescopes because of the normous amounts of abscuring aterial that lie in the direct path vision. Radio waves, however, in penetrate this medium freely nd through radio astronomy it is ossible to study this galactic centre nd' even distances beyond.

Interesting highlights thrown out om this study are such as the deterination of the radius of the Milky yay as nearly 50,000 light years; ne presence of hydrogen clouds and H molecule (hydroxyl) and the exisnce of other substances in intersellar space like cyanogen, carbon onoxide, formic acid, etc; the ature of exploding galaxies and the ost significant of them all, the enima of quasars, pulsars and the neuon stars. An imaginative journey to space which the author discusses worth a detailed reading. When ne comes to these objects, speculaon about the universe becomes a lking subject and this is how the ext rounds up with a peep into that intastic question: Does life or vilisation exist elsewhere in the niverse or are we unique on Earth?

It is a pity that the author, in is observise interesting work, has mitted to elucidate the phenomenon f 'black holes', and in describing arious radio telescopes of the world werlooked the one put up by TIFR

at Ooty where significant contributions are being made.

> S.K. GHASWALA 90, M. Karve Road Bombay-400020

THE FILAMENTOUS FUNGI— VOL. I INDUSTRIAL MYCOLOGY edited by John E. Smith and David R. Berry, Edward Arnold (Publishers) Ltd., 1975, Pp. xii+340, £12.50.

UNGI are showing an increasing impact on the applied aspects, not only in the production of alcoholic beverages, products of organic origin like citric acid, gluconic acid, antibiotics etc., but also such fields as pollution, flavour biosynthesis, etc. Recent advances in radiation genetics, biochemistry and physiology of fungi, have led to an increase in the exploitation of fungi for industrial use. The book is very useful to students of Industrial Mycology and such personnel who are directly involved in the pharmaceutical chemicals and food industries. The book is divided into 16 Chapters, each written by a specialist in that field. Chapters 1-6 deal with the structure and development, environmental control, metabolism, strain improvement, growth kinetics and historical development of fungal fermentation industry. The latter emphasizes that long before the advent of antibiotics, the fungal industry was in existence as is evident from cheese production, koji process and the manufacture of gallic acid which is used in tanning and printing industry. Chapter 7 deals with commercially important secondary metabolites, some of which are griseofulvin, gibberellins, etc. Chapter 8 describes the production of different organic acids like gluconic, citric, itaconic acid and other miscellaneous organic acids. Transformation of organic compounds by fungi is the content of Chapter 9. Certain chemical compounds when added to specific microbial cultures underge a specific modification. This ha led to transformation of steroid and some antibiotics and the chapte describes very neatly the intricacie of the proceses involved at the biolo gical and biochemical level. Som fungi produce enzymes like amylase pectinase, protease, cellulase, etc Chapter 10 describes the industria enzyme production and its import ance in food industry. Edible mush rooms are considered to be a delicacy In many countries consumption of mushrooms is increasing steadily Chapter 11 deals with the cultivation of Agaricus and other edible mush rooms and the present status of mushrooms industry with future propects. Chapter 12 describes th submerged culture production of mycelial biomass which could b used for two specific purposes—firs for using it as a flavouring agent an the second, for the production of proteins for human consumption Chapter 13 is devoted to orienta food fermentations where preparatio of soya sauce, koji, chinese chees have been dealt with. Chapter I deals with the industrial exploitation of ergot fungi. Ergot alkaloids have wide range of activity like central an sympathetic nervous stimulation, di rect action on smooth muscle (uterus arteriole wall) and production of hy pertension, vomiting, etc. The Chap ter- describes the principles and th problems involved with the fungu Claviceps purpurea, a representativ of ergot fungi. Chapter 15 deal with biodeterioration and biodegra dation by fungi. The book refer to the latest scientific finding which are included in a reference list at the end of each chapter.

> AIIT K. MISHR Professor of Microbiolog Bose Institute, Calcutta

"Competence in electronics is a measure of a country's advance"

Indira Gandhi

MEASURE BEL'S ROLE IN THE NATIONAL LIFE



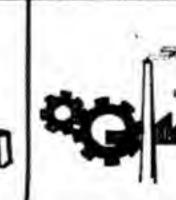
Railways and P & T:

off. VHF and UHF communication equipment and multi-channel radio relay systems. Computer based rolling stock movement and control systems for the Railways and subscriber monitoring equipment for the P & T



Balles!

Multi-channel microwave radio relay systems, Welkie Talkies, mobile and state communication equipment.



UMF tadio relay and pipeline monitoring systems for the oil industry. VMF communication systems for use in the sugar dustry and in open pit mines, and electronic

industry and in open pit mines, and electronic desk calculators, mini-computers, etc.

Television and Broadcasting:

Transmitters, antennas, camera chains and other studio equipment for TV, and TV picture tubes and components for the TV receiver set. Transmitters and studio equipment for broadcasting and components for radio receiver sets.



BEL's contribution becomes even more remarkable when one realises that BEL had to create the infrastructure for today's electronics industry in India at a time when electronics was virtually unknown to the country. Many organisations in this field today, directly or indirectly owe their existence to the pioneering efforts of BEL.



Meteorelogy:

Storm warning and cyclone warning adars, communication equipment for flood warning and commit.



BHARAT ELECTRONICS LTD.

BANGALORE GHAZIABAD (A Govt. of India Enterprise)

BELCM.7515

CIENCE REPORTER

HISTORY OF SECRET

CELLS, THE POWER

AT IS NEW IN POLYMER
NCE

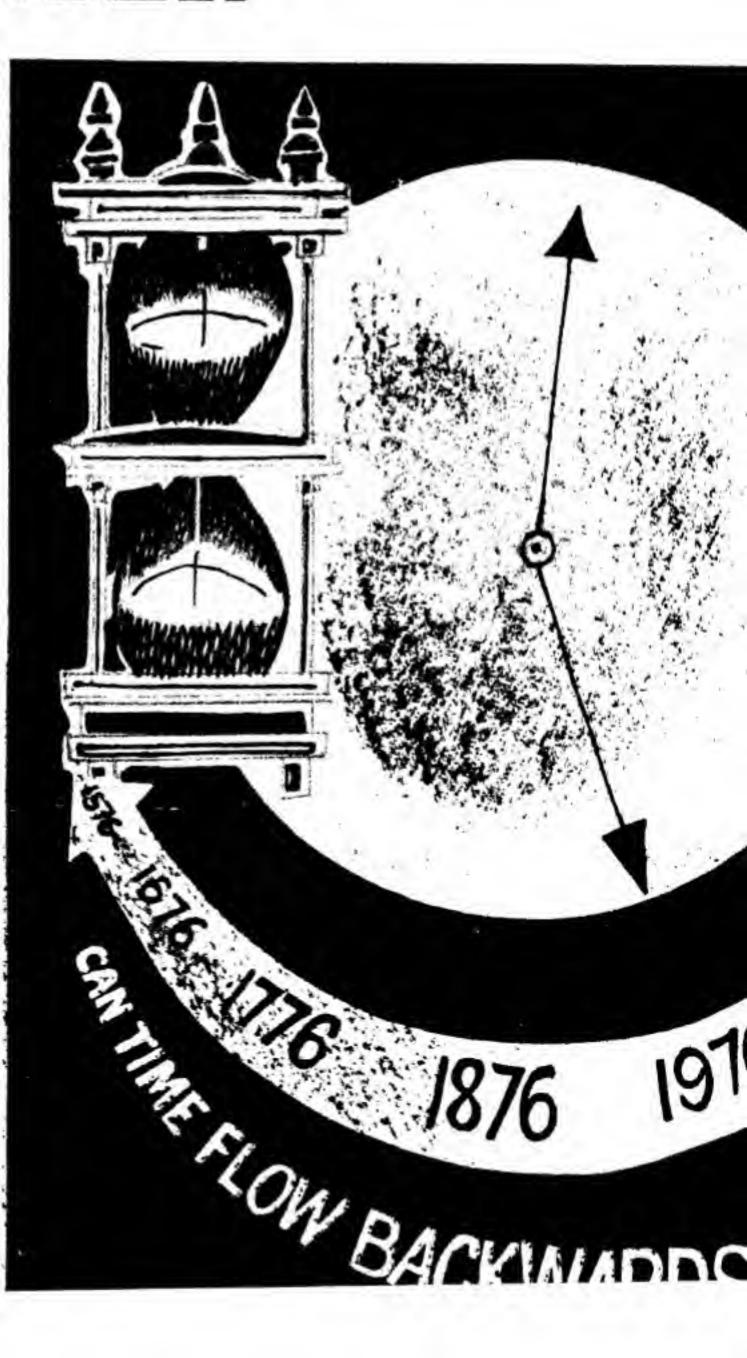
MUNICATION BY

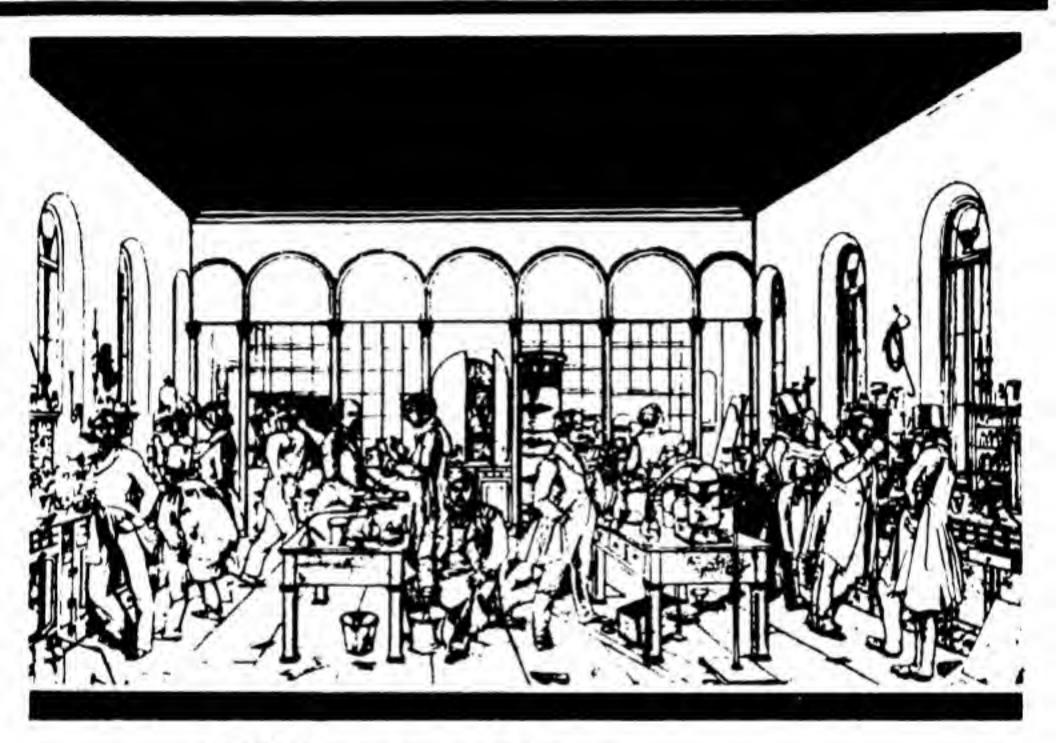
A INDUCES PHYSIOLOGI-EFFECTS



Re. 1.00

NCIL OF SCIENTIFIC DUSTRIAL RESEARCH DELHI-110001





Where the Pioneers have left

The key nature of alchemists role in laying the foundations of modern science, may be judged from only a partial list of basic scientific tools, associated with their names.

Chemistry had its origin in the laboratories of the alchemists. Alchemy eventually expired under the impact of science, but its tools and procedures were taken over by the scientists in the modern world, to utilize them for extending the basic discoveries still further and bringing them closer to the common man.



SARABHAI M. CHEMICALS

Where scientific tradition of ingenuity never dies.

COUNCIL OF SCIENTIFIC & INDUSTRIAL RESEARCH

ADVERTISEMENT NO. 2/76

It is proposed to appoint two Scientists 'F' (Deputy Director) for the Central Drug Research Institute, Lucknow.

Post I: Job Requirements

(i) To provide high level leadership for the overall planning and execution of multi-disciplinary research and development programmes in the field of drugs, both of natural and synthetic origin; and (ii) to coordinate the work of the medicinal chemists with that of bio-medical disciplines and R&D teams.

Qualifications:

The candidate should possess high academic qualifications in Organic or Pharmaceutical Chemistry with at least 5 years experience in Natural Product and Synthetic Chemistry with special reference to drug research and development and should be a recognized scientist in the field. He should have proven ability in guidance and management of research teams.

Post II: Job Requirements:

It is a very senior research post in the area of Fermentation Technology and Industrial Microbiology. The scientist will be required to provide high level leadership and planning in this field. He will have to liaise with industry, identify problems in the area and plan and execute R & D projects. He should be able to coordinate the research and development activities of the group with the national plans.

Qualifications

High academic qualifications in industrial microbiology or chemical microbiology or chemical technology with at least 5 years R & D experience in the field with proven ability to plan and guide fermentation/antibiotics research and development programmes and with experience of preparation of feasibility and project reports. He should have sound knowledge of the status of the fermentation based on pharmaceutical industry and should be a recognised authority in the field.

The selected candidates should be able to command the confidence of researchers in their respective fields and the industry concerned and be able administrators and image builders to the Institute.

Age Limit:

Below 50 years, relaxable in exceptional cases.

Salary/Conditions of Service:

The salary scale attached to the posts is Rs. 2000-125/2-2500. Initial pay will be fixed according to merits. The persons selected will be appointed on contract for a period of six years, which would be confirmed after an initial period of two years of satisfactory service. Other conditions of contract will be supplied on request.

Scientists/Technologists interested may obtain a standard proforma for sending their curriculum vitae from the Chief (Administration), COUNCIL OF SCIENTIFIC AND INDUSTRIAL RESEARCH, RAFI MARG, NEW DELHI-110001. They can also obtain a brochure on the aims and objects and the latest annual report of the Institute. Completed curriculum vitae proforma must reach this office on or before 27th March, 1976.

Convassing in any form and/or bringing in any influence, political or otherwise, will be treated as a disqualification for the post.

to our contributors

- SCIENCE REPORTER welcomes articles of absorbing interest on science and technology. Contributions
 published in the Journal will be paid for.
- Articles should be sent to the Editor, SCIENCE REPORTER, CSIR, Rafi Marg, New Delhi-110001.
- The form and manner of presentation of the subject should be easily understandable to the undergraduate level.
- The length of the article, written exclusively for the Journal, may be about 2500 words.
- The matter should be typewritten, double space on one side of the paper; the original and a carbon copy are to be sent.
- The article should preferably be illustrated; captions and legends typed separately and attached at the end of the article. Photographs should be on glossy paper.
- While quoting names of scientists, etc., their initials, nationalities and periods of research under reference should invariably be mentioned. All weights and measures should be given in Metric Units.
- A short note about the contributor should also accompany the article. The note should contain age, academic accomplishments, important assignments held, fields of research and hobbies.
- Articles or illustrations published in the Journal can be reproduced with permission of the Editor.
- The Editor reserves the right to reject even invited articles without assigning any reason.

SUBSCRIPTI	ON
FORM	

To

The Editor
SCIENCE REPORTER
C.S.I.R., New Delhi-110001

Name	
Full Address	
(in capitals)	
PIN	
(Old Subscription No)	Signature
NOTE: Please mention old Subscription No in M.O. co	repen also.



VOL. 13 MARCH 1976 NO. 3

132 LETTERS

MAIN ARTICLES

135 Cryptography—the science of secret writing
139 Can time flow backwards?
141 Fuel cells—the power-packs of tomorrow
146 Polymer science—some recent trends
150 Why do animals migrate?

Prasanta Choudhary
A.W. Joshi
S.S. singh
Swaminathan Sivaram
B.B. Jana

154 SCIENCE SPECTRUM

Communication by satellites—Discovery of monopole doubted—Pari non-conservation and weak interactions—Basic aspects of ultrasonics On Public Language programming—Uses of organotin compounds Fruit and flavoured yoghurts—Sulphur for plants—Mimicry in lan animals—Stickleback fish—sexual responses and behaviour—Personal determines diseases—Tungro disease of rice—Defluoridation of water Nalgonda technique

178 NEWS AND NOTES

Nobel physicist Dr. Heisenberg passes away—Prof. S.C. Maheshwari interview—International Symposium on Industrial Toxicology—Symposium on Applied Magnetism

181 MEDICAL NOTES

Vitamin B₁₇—an anticancer agent? Yoga induces physiological effects Separation of protein fractions from blood plasma—Herpesvirus cand vaccine developed

184 PLANETS AND THEIR POSITIONS-APRIL 1976

185 SCIENCE FOR THE YOUNG

The vast wealth of oceans—How water-meter works—Science who word puzzle

189 SCIENCE IN INDUSTRY

Lead extraction technology-Magnetic tapes for cassette tape-recorde

191 BOOK-REVIEWS

Energy Under the Oceans-Advanced Inorganic Chemistry-Introduction to Experimental Nuclear Physics-Experiments in General Chemistry

Annual Subscription

cience Reporter is issued monthly. he Council of Scientific & Industrial

esearch assumes no responsibility

r the statements and

lvanced by contributors.

nland : Rs. 10.00

oreign: \$ 5.00

Editor: S.P. Ambasta Asstt. Editors: C.B. Sharma, Zaka Imam

Editorial Staff: Dilip M. Salwi, Nisha Misra Seles & Advt.: G.N. Jaswal, G.E. Salpel

Production: V.S. Chaturvedi



Mushrooms (S.R., Oct, 75)

Sir, Mushroom soups and stews are been popular dishes for a long me. They can be used in the prepation of *Pulav*, dry or curried dishes and vegetables like cabbage and uliflower. Mushroom pickles are so gaining popularity these days.

Spawn bottles can be obtained om the following against payment:

1. Volvariella. Mr. T.K. Ayavamy, Blue Hill Farms, Coimbatore1040.

 Agaricus bisporus. Head, Deptt.
 Botany & Plant Pathology, Agriltural Complex, Solan, Himachal adesh.

Artificial manure is prepared by mposting wheat straw (preferably opped into 5-8 cm long pieces) ong with a few chemicals:

Wheat straw: 30 bundles (average

wt. 8-10 kg/bundle)

Wheat bran: 30 kg Super phosphate: 9 kg Ammonium sulphate: 9 kg

Urea: 4 kg Gypsum: 25 kg

Urea, superphosphate and ammoum sulphate are mixed with the wet w dust and kept overnight which leps in uniform mixing with the ater-soaked wheat bran and straw is following day. The complete mixire is staked or heaped in a ractanular shape (183 cm long and 122 cm gh, which may come to about 91.5 to 22 cm wide). On the 8th or 10th day he heap is rebuilt by cutting from the de (part by part) and spreading on the ground after mixing gypsum.

Regular watering is necessary to roid drying. During composting should be broken and rebuilt as mentioned above, before the temperature in the centre reaches 72°C. This may be required to be done in 3-4 days. The compost is ready in 3-4 weeks when the ammonia smell is not perceptible. Later, it is advisable to pasteurise the compost by putting it in a steam heated room (temp. upto 47.5°C) for about 2 days before filling into the trays for cultivation.

N.S. SINGH Fruit & Veg. Tech. Disc. CFTRI, Mysore-13

Science & Technology Film Centre

Sir, Despite all the efforts of Government, many colleges and universities lack the latest and sophisticated scientific equipment. The reasons are: (1) mass expansion of educational institutions, (2) rising cost of equipment, and (3) lack of proper accommodation.

No college or university can have the full range of apparatus in chosen fields as science and technology is expanding at a rapid speed. The complaint often made by many colleges is lack of equipment. The solution to this problem is to use mass media like 'films' on science and technological subjects.

Subject-wise scientific and technical films (16 mm) can be produced and loaned to colleges and universities. Organisations like CSIR, UGC, etc., can set up 'Scientific and Technological Film Centre at a place in the heart of the country. They can loan films to colleges and universities. Of course, we are now having general films on subjects like sound, electricity, etc. what we need is films on special subjects like (1) nitrogen (2) the cumbustion process, (3) lasers, (4) mass spectrograph, and (5) electron microscope, etc. Also films can be produced on the work carried out by laboratories under CSIR, ICAR, ICMR, BARC and on research institutes like IITs, TIFR, BITS. etc.

By seeing these films (with sour track and explanation) a student of have first hand information on the latest equipment and the subject. Wherever possible, the commentation in the film should be by a reput scientist on the subject. These can be distributed throughout the country. The colleges and universitis seeking these films can bear to freight charges. To start with, copies on each subject can be produced. The advantages are:

(1) The student gets first har information on the latest development ment in the subject and equipment

(2) The films can be sent to ever nook and corner;

(3) Teachers in colleges may not be proficient in all subjects. Her the students will have the advantage of hearing from an authority on the subject, which they will appreciate more; and

(4) They will inspire the your students to emulate the great scientists.

In this connection the possibility of collaboration with countries like the U.S.A. or Britain may be explored.

We should also use 'radio'—anothe important mass media for this purpose. Our motto should be: Science to serve society, Society to support science.

A. JAGADEES Nellore, A.I.

Mercury's period of revolution

Sir, The period in which Mercur completes one revolution around it axis is given as 88 days by M. F. Khan (S.R., Oct. 1975, p. 505). This wrong. It was at one time thought that Mercury was in locker rotation with sun. However, rada measurements have shown that Mercury revolves around its axis in about 58 days. The current accepted values 58.65 days.

C.S.G. PRASA

Deputy Chief Edito

The Macmillan Company of Indi

Ltd., 2/10, Ansari Road, Daryagan

New Delhi-11000

Ultramarine

Sir, About Pigments by V.V.R. astry, (S.R. Sept., 1975) I would ke to say that the blue pigment Itramarine (sodium-alumino-silico alphide, the formula of which has een established by Hofmann as land AleSiaO₂₆S₄) is an artificial subtitute for the precious natural pigment, lapis lazuli.

Ultramarine has many shades and clours and it is not restricted to lue alone. The colour is associated with the composition and constitution of the pigment. This commercial lue ultramarine, when heated in current of fire, nitric oxide or ydrogen chloride (HC1), yields a colour or red ultramarine. It is ossible to produce ultramarines of ifferent colours by the control of the technique.

MIR AHMED ALI P.G. Inst. of Basic Medical Sciences Univ. of Madras

I do agree with Mr. Ali on the oint that ultramarine has many nades. In fact, commercial ultraarine blues are available ranging om red shade blues to very green nade blues. Ultramarine is made by rolonged heating at 800°C of a ixture of calcined kaolin, sodium arbonate, sulphur, silica and resin. y varying the proportions of the raw saterials, the shade of the pigment an be varied from bright violet to luish green. Though fast to light, eat and alkali, ultramarines are eadily attacked by acids resulting in ess of blue colour.

V.V.R. SASTRY
Reg. Research Lab., Bhubaneswar

Pine needles

Thanks for the informative and steresting article Technology deveped for pine needles by Zaka mam (S.R., Nov., 1975).

I want to add that a unit to produce

fibres from pine needles has been set up by an entrepreneur at Kainchi, Nainital in U.P. It is possible to develop this industry on a cottage scale in the entire northern hill belt. Capital investment required to set up such a unit is not more than Rs. 5000.

ANIL K. JAIN
Deptt. of Botany
K.L.D.A.V. College, Roorkee

Pineapple in barren soils

Sir, Some 40,000 acres of former waste land in Jalpaiguri and Darjee-ling Districts of West Bengal, which had defied all earlier attempts at conventional cultivation, have become highly productive by planting pineapple. There must be many similar barren areas all over the country suitable for pineapple cultivation and capable of yielding abundant harvests of this luscious fruit.

M.C. PHILIP
14. Jhowtolla Road
Colcutta-700207

Fluorescent tube

Sir, The article How fluoresent lamp works by Dilip M. Salwi (S.R., Nov., 1975) was very informative. I wish to add the following information to the article.

- (i) Frequent starting of the fluorescent lamp decreases the life of the tube. If the fluorescent tube is switched on and off to the minimum, its life will be longer than normal.
- (ii) The heat produced by a fluorescent tube is four times less than that of a filament lamp for the same amount of light produced.

R.K. YADAV 4567, East Ghamapur Jabalpur-482001

Plants and air pollution

Sir, I read with interest the article

Plants as indicators of air pollutio (S.R., Sept., 1975). The author ha made reference to the use of lichens for study of environmenta pollution. I would like to give, fo the benefit of your readers, som useful references for the study.o pollution by the use of lichens. Use o lichens in estimating air pollution ha been reviewed in a popular article 'New tasks for lowly plants' by O.L. Gilbert (New Scientist, 1970, 46 288-289), and evaluation of the pollution and draught hypothesis in relation to lichens and bryophytes in urban environment has been ably recorded by LeBlanc and D.N Rao (Bryologist, 1973,76, 1-19) A valuable publication Air Pollution and Lichens has been brough out in 1973 by the University o Toronto Press, Toronto, edited by B.W. Ferry, M.S. Baddelley and D.L. Hawksworth. This book contain many interesting chapters written by scientists who have been doing good work in this field of study.

In 1968, the First European Congress on the Influence of air-pollution on plants and animals was held in Wageningen, and the proceedings of the Congress have been published by the Centre for Agricultural Publishing and Documentation, Wageningen.

No doubt, we have much scope for interesting work to be done in the direction of plants and air pollution in our country.

> S. SANKARA SUBRAMANIAN Prof. of Chemistry JIPMER, Pondicherry-

Suggestions

Sir, I have been keeping a close companionship with S.R. for the las four years. As a science student, find it useful for my career.

I have a special attraction for the topics published under the section 'Science For The Young.' I an thankful to you for starting a new item 'Believe it or not'. I hope thi teresting item will continue in lissues.

I would be glad if you publish ossword puzzles regularly.

NANDA KISHORE JENA Dept. of Botany S.C.S. College, Puri (Utkal)

1

Sir, Thanks for publishing All sout explosives (S.R., Oct., 1975). I ad it with much interest. Will you

please publish some articles on 'Communication'?

M. NAGANATHAN TTC Colony Jabalpur

Ш

Sir, Please publish an article on the manufacture of tartaric acid from tamarind leaves and pulp.

> B.K. CHEMICALS Shahganj, Aurangabad

Sir, Thanks for the informative and interesting article Antitranspirant reduce water needs in agriculture by M.K. Sadhu (S.R., Nov., 1975). Kindly publish articles on (i) meios and recombination of genes, and (i histology of root, stem and leaf.

BIR PRAKASH JAISWA Science Colleg Patna, Biha

CIENCE SPECTRUM (Continued from page 177)

agnesia, serpentine and defluoron-2. n-exchange resins, saw dust carbon, fluoron-1, magnesia and serpentine d not prove useful beyond benchale.

A domestic defluoridation unit as fabricated for use with defluon-1. Pilot plant studies were rried out at Gangapur (Rajasthan), ing carbion. To overcome the oblems faced with saw dust carbon, fluoron-1 and carbion, a medium fluoron-2 was developed in 1968 r removal of fluorides from drinkwater. Extensive trials with the dium, both on laboratory and in e field, have shown that it does t suffer from most of the handicaps e some of the indigenous materials veloped earlier. Using defluon-2, two plants with a capacity to at 91m2 per regeneration were stalled at the Municipal Corporan, Nalgonda (A.P.) and Central aining Institute, Hyderabad.

Though defluoron-2 process was excessful in removing fluorides, the generation and maintenance of the ant required skilled operation sich may not be readily available rural areas. In order to overcome is problem, a new method has en developed by NEERI in 1973, he method has been named "Nal and technique". It is simple and

adaptable even by illiterate persons in villages. Incidentally, the cost of defluoridation has also been brought down considerably.

The new method involves in situ precipitation of fluoride from water, and comprises addition in sequence of bleaching powder, lime and filter alum to the fluoride water, followed by stirring for ten minutes and settling for one hour. The quantity of alum required to be added depends upon the fluoride and alkalinity of raw water. Lime hastens settlement of precipitates and bleaching powder ensures disinfection. The dose of lime is 1/20-1/25th that of filter alum. The fluorides in the treated water are reduced to about I mg F/I when the alkalinity of the raw water does not become limiting. Conditions comprising high fluoride and low alkalinity are not usual in India. If such conditions are encountered, the alkalinity of the water can be increased with lime. The technique can be used both for domestic as well as for community supplies.

The Nalgonda technique has been tested extensively in the laboratory, model plant and pilot plant scale.

Demonstrations. Teams have gone from village to village in Andhra Pradesh and Rajasthan demonstrating and explaining the process of defluoridation.

Technique for alum tablets pre paration. Table's are convenient to handle and administer in villages The Andhra Pradesh Governmen has taken keen interest to buy table making machines for this purpose Tablet machines require power, skil led maintenance and expert super vision. To avoid these, a simple technique for the preparation of alum tablets without resort to a machin was developed. It does not require machines or electricity and involve addition of a little quantity of wate to raw alum and melting it. The melt is then poured into mould which are either of wood or alka thene. Using these moulds, ove 60,000 tablets in assorted sizes (5 to 50 g) were made. The moulds are cheap and yet long lasting and car be made in villages. The tablet can also be prepared in homes.

Cost economics. On the basis of the field work and revised costs of chemicals, cost per capita/annum has been caculated at Rs1.86 to Rs. 2.00

Enquiries attended. Information of the process has also been sought from Bangaladesh, Kenya, Tanzania Canada, Australia and the U.S.A.



PRASANTA CHOUDHARY

statecraft, whether during IN peace time or war, secret ommunication plays an important ole. One of the earliest means dopted for sending secret messages, s reported by Herodotus, the Greek istorian of 5th century B.C., conisted in shaving the head of a slave nd inscribing a brief message on the calp; then to wait for a month or o till the hair grew afresh and overed the inscribed message comletely. The slave was then sent to the erson concerned, who would proced to shave off the hair and read the nessage inscribed on the scalp. his method though crude and rimitive was nevertheless quite igenious. No one, of course, would ream of employing such a method oday because of obvious disadvanages and limitations.

Concealment devices

Secret communication, in general, alls into three major classes: oncealment-devices, transposition iphers and substitution ciphers. The example cited above belongs to the class of concealment-devices. One of the most widely used oncealment-devices in the early

Cryptography plays an important role in war and peace. A device as ancient as civilization, it is receiving increased attention in this age of fast communication

days was the 'grille'. In this, a number of openings were made in a sheet of paper more or less in a linear pattern. This paper was then placed over another of identical shape and size, and the requisite message was written down through the openings. The next step was to camouflage the message by filling up gaps with words which on the whole made a coherent test. The person to whom the message was sent had an identical grille. He would, on receiving the message, proceed to read it by superposing it on the sheet containing the message through the openings in it.

Codes and ciphers

Nowadays codes or ciphers, belonging to transposition or substitution class of cryptography, are used for sending secret messages. In codes, a pre-arranged word is employed to represent several words of the plain text or message. A pre-

arranged word may also, in son cases, be employed for the who message. The variety of message that can be sent in the coded for is necessarily restricted. This is no the case with a cipher in which ar thought can be sent. Reading coded message, of course, requires code-book. Inspite of such limits tions, codes have some advantage over ciphers. A message can b rapidly encoded or decoded an needs less care. The breaking of single message in cipher gives th key to the whole system of ciphe that is being employed. This i however, not necessarily the case wit a code.

J. Laffin, in his popular account of cryptography Codes and Cipher mentions that Navy and Infantry u code and ciphers respectively. It interesting to note that code-boo of warships are bound in lead so the they can sink easily when throw overboard into the sea.

ighers and their characteristics

In transposition ciphers, letters of the plain text are merely rearranged coording to a given plan, so as to et a text which appears as a succession of letters devoid of any sense meaning. For example, if we write the letter of the words of the tessage COME AT FIVE in reverse reder, we get EMOC TA EVIF, thich appears quite meaningless.

In a substitution cipher, the letters the plain text are substituted by ther letters (which differ, in general, om the original letters), figures, mbols or numerals. Julius Caesar credited with the discovery of a ry rudimentary type of substitution pher. All he did was to shift each plain text three places down the phabet (explained later).

The aforesaid two instances illusate the principle involved in the two
ain types of ciphers. In practice,
good deal of complications are
eliberately introduced in the scheme
transposition or substitution as
a case may be, so as to make the
eciphering exceptionally difficult
acept to those who have the clue
they. Sometimes a mixed type
pher involving the both transposion and substitution systems is
apployed to a plain text message to
ake the original message indecipherole except to the initiated.

Perhaps the simplest type of transosition cipher is the one known as oute transposition cipher. Suppose the message is I NEED REINFOR-EMENT IMMEDIATELY. We rite the message in the following cometrical pattern of an 8 × 4 ctangular array, the 3 blanks re-



"The code message meant the use the other tank"

maining in the array being filled by Xs. Then we begin with the letter at the upper right hand corner, proceeding down and up cipher,

1	N	E	E	D	R	E	1
E	M	E	C	R	0	F	N
N	T	1	M	M	E	D	1
X	X	X	Y	L	E	T	A

as following: INIA TDFE ROEE LMRD ECMY XIEE NMTX XNEI. Or writing in groups of five letters as is the custom, viz..

INIAT DFERO EELMR DECMY XIEEN MTXXN EI

This cipher is easily solved and as such has little utility. Simple variations of the route transposition are possible, but we will not consider them here.

Here is another simple type of transposition cipher known as Chinese cipher, so-called because the message runs up and down as in Chinese. Consider the following message HAZARDOUS TO STAY HERE WE ARE GOING BACK NOW. By writing in a serpentine fashion this can be arranged into six columns of six words as follows:

W	G	E	T	S	Н
o	0	R	A	0	A
N	1	A	Y	T	Z
K	N	E	Н	S	A
C	G	W	E	U	R
A	В	E	R	0	D

Now reading downwards each row of six letters, the cipher would read WGETSH OORAOA NIYATZ KNEHSA CGWEUR ABEROD

Another simple type of transposition cipher is the vertical parallel cipher described below. Suppose the plain text or message is MEETING ON TUESDAY. We write this message in two columns as follows:

M	N
E	T
E	U

T E I S N D G A O Y

The cipher message would then the following:

MN ET EU TE IS ND GA O or writing in groups of five, as is a custom in secret communication, would be:

MNETE UTEIS NDGAO

The substitution cipher

The types of cipher in comm use are, however, substitution ciph on which a good deal of thought a ingenuity has been expended to evo a system which is almost indeciph able except to the initiated. Ordina ly, substitution ciphers can be solv (a term which implies the decipheri by those who do not have the ke if a sufficiently long message intercepted. The general method solving involves finding out t frequencies of letters in the int cepted message and comparing w standard frequency lists of vario letters in the language concerne An attempt is then made to ident the various letters of the ciph message on the basis of such co parison. For example, it is known that the most frequent letter occurri in a text in English is 'e'. So o can proceed by identifying the me frequent letter occurring in a lo cipher message with 'e'. The ne frequent letter is 't' which can similarly identified, and one c proceed in this way by a process trial and error till a meaning message emerges. Such a proce requires a good deal of time a patience of the solver. It is interesti to note that a few detective stor have been constructed around the method of solving, as a theme, by Conan Doyle and Edgar Allen P (see p. 207, One, two, three infin by G. Gamow).

ome simple substitution ciphers

The simplest type of substitution pher is that in which identical plain at letter is represented by the same pher equivalent. The simplest way employ such a system consists in riting down the plain sequence and e cipher sequence superimposed one love the other. It gives the respective plain and cipher equivalents.

Reference has been made earlier a rudimentary form of substitution pher used by Julius Caeser. In this rm each plain text letter is replaced a letter (cipher alphabet) which is ree places down in the usual phabet sequence as follows:

Plain text alphabet: bcdefghklmnopqrstuvwxyz Cipher alphabet: XYZABC

EFGHIJKLMNOPQR TUVW

Suppose now that the plain text essage is "Wait". This will be ciphered as TXFQ, since the cipher quivalent of w is T, that of a is X, hile the equivalents of i and t are and Q. This is too easy a cipher of hence not worthy of much tention.

A better procedure of substitution ould be to make the plan of subitution not systematic as in the oresaid example, but more or less an arbitrary nature. But, since vo sets of alphabet equivalents in hich one is in an arbitrary order are ot easy to remember, a simpler ocedure consists in writing down rst an easily remembered key word nd then following it up with the tters of the alphabet which do not ocur in the key, in their usual quence. Suppose we take CIPHER the key word, the plan of substituon will be as follows:

Plain text alphabet: a b c d e f g i j k l m n o p q r s t u v w x y z Cipher alphabet: C I P H E R A D E F G J K L M N O Q S T U W X Y Z The message 'wait' ill thus be enciphered as WCDT. It this plan, note that several of the

plain and cipher alphabets are identical.

A mechanized contrivance known as St. Cyr Cipher, which is as simple as the two procedures given above, may be evolved as follows.

Two scales (which may be made of cardboard or wood or any other material) having the roman alphabet sequences imprinted on them are allowed to slide one against the other. One of them (say the upper one) is kept fixed while the other slides against it. The letters are imprinted at identical distance apart in both the scales in the usual alphabet sequence. In this case we use a key letter. Let this key letter be P. We slide the lower scale along until P comes directly under A. Then the cipher equivalents to be used are under the plain alphabets of the upper scale.

Numerical substitution

A very simple numerical substitution alphabet may be evolved as follows. From the 26 letters of the alphabet leave out J and write them in a square array as follows numbering the rows and columns from 1 to 5.

2 3 4 5 Q A F v L G 2 B R w М 3 C н S X N T D 1 0 Y 5 E K U Z P

Then the letter A may be indicated by 11 (its row and column numbers), O by 43 and so on for all the 25 letters. A plain text message will be ultimately enciphered in terms of numerals.

Polyalphabetic substitution ciphers

The central idea involved in the solving of a cipher message is that a long message of a plain text shows definite letter frequencies which inter alia is utilised in the identification of

cipher letters representing plain alph bets. By using more than one ciphe letter to represent each of the plai alphabets according to a scheme of sequence, one can suppress th characteristic observed frequence pattern of letters in the particula language by employing a monoalpha betic system of substitution. Thus particular cipher letter, for example A may be used to encipher the plai text letter 't' for a given pa of the message, then another ciphe letter B may be used to enciphe the same plain text letter 't' fo another given part of the message Likewise, the cipher letters C, D, I etc., can each be used to enciphe the plain text letter 't' successively for other given distinct parts of who message, so that 't' will ultimate be enciphered by more than or cipher letter in the whole message Similarly, each of the remaining plai text letter may be enciphered each b more than one cipher letter in th whole message following a give scheme. Such systems are known a polyalphabetic systems, and tal two distinct forms as and when the alphabets are used periodically of aperiodically, i.e., when the key-wor employed is repeated successive or a text from a book is used as th key for enciphering.

The principle that lies at the base of polyalphabetic systems was devised in 15th century A.D. by the Italia architect Leo Battista Alberti. He inserted key letters at intervals in he cryptogram to indicate which alphabet would be used for the next fe words. Alberti's system was improved upon by several persons interested



"Headquarters! You got the coomessage wrong. I had asked for guerilla fighters."

exid Kahn in an article in Scientific merican July, 1966 recalls that for some 300 years this system emained essentially impregnable."

In 1863 Friedrich Kasiski, a retired ferman infantry major, discovered and published the general method for the solution of polyalphabetic ciphers with repeating keys. Kasiski's technique for breaking such ciphers stimulated cryptographers to devise more agenious enciphering schemes. They roposed using keys that did not epeat such as the text of a book. In 1883, however, a French language eacher Auguste Kerckhoffs devised

the general solution for polyalphabetic ciphers. Kerckhoff's technique can solve any polyalphabetic cipher except one with a key that never repeats, and contains neither meaning nor pattern as does a passage of a book. Such a pattern-less non-repeating key system, which is theoretically unbreakable, is called 'one-time system', and is used for diplomatic communication of highest importance.

One of the important developments of modern cryptography is the use of specially devised machines for enciphering and deciphering. They have been develoed to a high degree of sophistication although simp machines such as the Hagelin a others were in the market by the fi half of the 20th century.

Further reading

- Kahn, David. Codebreakers: T Story of Secret Writing, Collie Macmillan, Toranto, 1969.
- Laffin, J., Codes and Cipher Secret Writing Through the Age Abelard-Schuman, Londo 1964.
- Ball, W.R., Mathematical Recretions and Essays, (11th Edition revised by H.S.M. Coxete Macmillan, London, 1939.

Statement of ownership and other particulars about the periodical

SCIENCE REPORTER FORM IV

(See rule 6)

Place of publication

Council of Scientific & Industrial

Research, Rafi Marg, New Delhi

110001

2. Periodicity of its publication

Monthly S.P. Ambasta

 Printer's name Nationality

Indian

(Address)

CSIR, Rafi Marg, New Delhi-110001

4. Editor's name

S.P. Ambasta

Nationality

Indian

(Address)

CSIR, Rafi Marg, New Delhi-110001

 Name and addresses of individuals owning the newspaper and partners or shareholders holding more than one per cent of the total capital

 S.P. Ambasta, hereby declare that the particulars given above are true to the best of my knowledge and belief.

> Sd/-(S.P. Ambasta) Signature of publisher

1-3-1976

N space, we can move forwards or backwards, to the left or to right, upwards or downwards, it in 'time' we move only forwards, ver backwards (except in imagition). This suggests that the flow 'time' has a definite direction and at passage of time is not controll-le as movements in space.

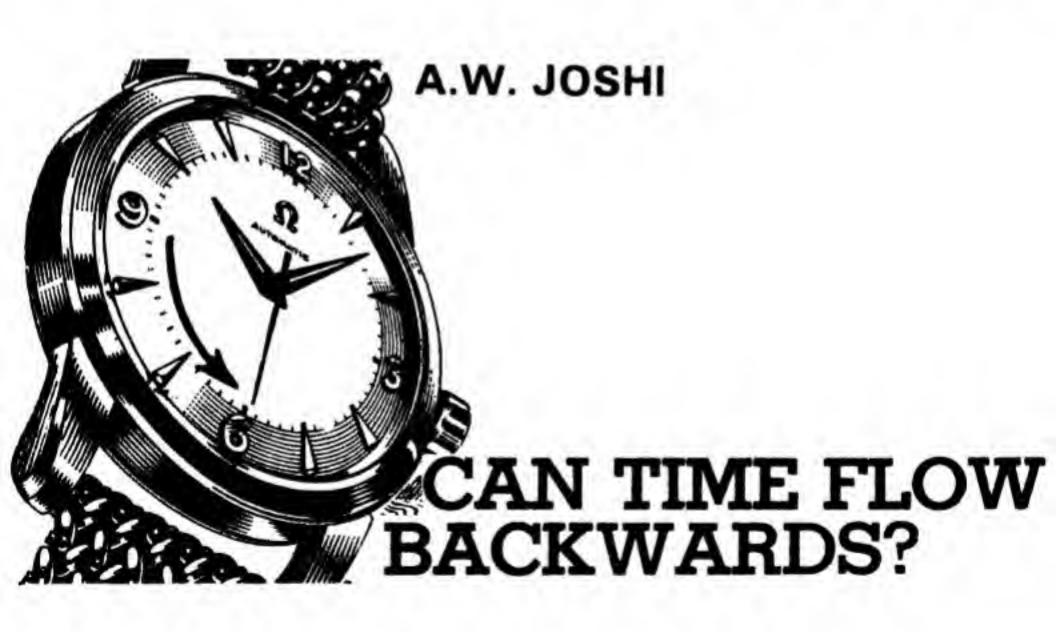
We shall try to show in this article, some examples, that in principle is not impossible to make time flow ckwards, but it is highly improble, that is, its probability is so small at it can be taken as zero for all actical purposes.

Man has always wanted to re-live the past, but he has been mystified by the one track flow of time

the term "entropy" to denote the disorder of a system. The entropy of a highly ordered state of a system is small while that of a disordered state of the system is large. In a sense, entropy is the measure of the disorder of a system. Therefore, when we say that orderlines in this universe is constantly decreasing, it means that the entropy of the universe is constantly increas-

and is, in fact, heading towards that state. This gives us the psychological impression of the flow of time. It in a system all motion is stopped (even at the subatomic level), the flow of time will stop for that system.

The entropy of a system depends on the number of ways in which the system can be realized (or prepared). Let us consider a few examples to elaborate this concept Suppose ten coins are thrown a



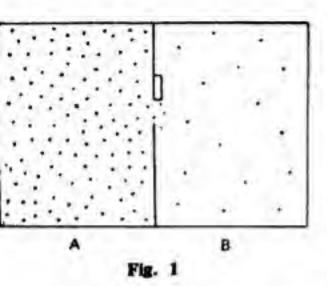
utropy

First let us try to understand what e mean by the passage of time. It this universe, all bodies from ars to the minutest submicroscopic articles are in eternal motion. Hysicists are convinced that this notion is such that the orderliness this universe is constantly decreasing. We are going from an ordered

ing. This principle is called the second law of thermodynamics, which states that the entropy of a closed physical system always increases with the passage of time. For this reason, entropy was called the "arrow of time" by Sir Arthur S. Eddington, a British philosopher-scientist. The above law also suggests that nature prefers the state of maximum entropy

random and the number of head and tails is observed. Commo sense tells us that we should expect the number of heads to be close to five. Is it not possible to get a ten heads (or tails)? It is not impossible, but it is improbable. Let us can the state of the ten coins in which there are n heads and 10—n tails at the "nH/(10-n)T state." A simple

To the sale



lculation based on probabilities ows that if we throw the ten coins = 1024 times and note the various ites, there is a chance that one these states will be the 10H/0T ate and other will be the 0H/10T ate, whereas the state 5H/5T can cur 252 times. The probability getting all heads or all tails is 1 1024, while that of getting equal imber of heads and tails is about 1 4. This shows that the entropy the 5H/1T state is much larger an that of the 10H/0T or 0H/10T ate.

It we just double the number of ins, the probability of getting all heads (or tails) in a throw is about in a million (2²⁰~1.05×10⁶), hile that of getting 10 heads and tails is about 1 in 6, which is about 0,000 times that of geting all ads or tails. If we increase the imber of coins to 100, we find that is chances of getting 50 heads and tails in a throw are about 10²⁰



f time were made to flow backwards, would certainly undo the mistake did 25 years ago"

times those of getting all 100 heads or tails. We see that although it is not impossible to get all heads or tails in a throw of 100 coins, it is very highly improbable.

In a throw of n coins, let us regard the state with all heads (or tails) as a state with the maximum order. Such a state has a very low probability of occurrence and can be obtained only in one way; hence its entropy is the lowest. The state with equal number of heads and tails is the most probable state and corresponds to the highest entropy. This state has the minimum order.

Suppose we throw 100 coins. We expect that the number of heads will be very close to 50. Now suppose that we turn upside down all the coins showing tails so that all coins are showing heads. We have a highly ordered state. Suppose a sudden gust of wind comes, lifts all the coins in the air and then they tumble back to the ground. Once again there will be approximately an equal number of heads and tails and we shall have a disordered state. This is what we mean by saying that nature prefers a state of maximum disorder.

As our second example, consider the case of a monkey playing with a typewriter We assume that the monkey keeps on punching the keys of the typewriter completely at random at a rate of one key per second. The typewriter has 26 small letters, 26 capital letters, 10 numbers, about 15 or 20 different signs or symbols, and a space bar. As a round figure, suppose there are 80 different characters and the probability that the monkey types any one of these is the same. The average time in which the monkey types one desired letter correctly is about 80 seconds. The expected time in which the monkey would type a two-letter word (such as "to") is 80s seconds, which is about 107 minutes. The average time in which the monkey may type a four-letter word (such as "King") correctly is over a year

(one year = 3.15 × 107 seconds). No consider a short sentence such a "The God is in Heaven" which contains 20 characters. The average time for a monkey, who is typin randomly, to type this sentence correctly is 80° seconds or 10° seconds or about 1000 years, which many times the lifetime of th universe. Thus, once again we ca say that though it is not impossible for a monkey to type the sentence correctly, it is highly improbable. I fact, the probability is so small the for all practical purposes we ca regard the process as impossible The above sentence is highly ordere while the monkey's typing is highl disordered. The "entropy" of th above sentence is therefore very sma while that of the monkey's typing very large.

Coming to physical processes, le us take the case of heat. The secon law of thermodynamics, in another form, states that heat always flow from a hotter body to a cooler bod just as water always flows from higher level to a lower level. Micro scopically, we know that heat arise due to the random molecular motion The average molecular velocity an energy in a hotter body are greate than those in a cooler body. If hot body and a cold body are i contact and are left to themselves heat will flow from the hot body to the cold body until the temperatur of the two equalizes.

Is it possible to make heat flow from a cooler body to a hotter body. The answer is, yes. This is exactly what is done in a refrigerator and it ice factories. In an ice factory, water (which is to be frozen) is the cooler body; the surrounding atmospher is the hotter body. Heat is made to flow from water to the atmospher so that water becomes cooler and finally solidifies. In order to appreciate this, let us ask a similar question about the flow of water: Is possible to make water flow from lower level to a higher level? The

a bucket and lifting it, or by using a electric motor which pumps up ater from a well. Of course, we are to spend some energy (physical, nemical, electrical, etc.) in order to ake water flow against gravity. It is also in the case of heat we have to send some external energy in order make heat flow from a cooler ody to a hotter body.

Finally, consider the case of press-

re. Suppose we have two vessels, A nd B, one containing a high pressure is and the other containing a low preure gas, as shown in Fig. 1. Suppose e two vessels have a common wall nd there is a window between the vo which can be controlled from utside. If the window is opened, as from the high pressure vessel will flow to the low pressure vessel unitl the pressure equalizes. What happening in the process? To nswer this we remember again that ressure is the result of random molelar motion. The high pressure namber has a higher density of olecules than the low pressure namber. When a molecule of vessel tries to pass through the window, can do so with ease because the robability of its colliding with nother molecule in its path is small. n the other hand, if a molecule of essel B tries to enter vessel A through ne window, there is a high probability nat it will collide with another olecule and will be stopped in its ath. Thus in any sufficiently long iterval of time, more molecules are kely to travel through the window om vessel A to vessel B than vice ersa.

It is possible, for a short interval of me, that a molecule may be fortunate nough to cross the window from the essel B to the vessel A against the acreasing pressure. Then we might ay that this particular molecule is noving backwards in time because contributes to decreasing the atropy of the system. However, it obvious that this cannot happen

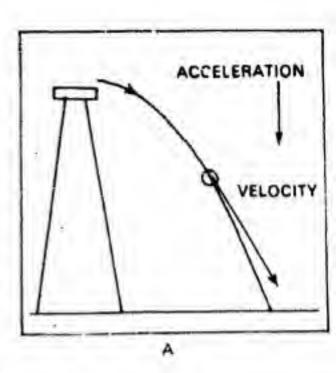
with many molecules or over a longer period of time. It is all a question of probabilities.

All these processes, such as the flow of gas from a high pressure region to a low pressure region or the flow of heat from a hotter body to a cooler body, determine the direction of time, because they are the processes in which the entropy increases. It is the entropy of a system consisting of a large number of particles which gives us the feeling of a direction of time. But, for a single microscopic particle and for processes which last for intervals of the order of 10-25 second, it is evident that both the directions of time are almost equally probable.

Time reversal

If, by any means, we make the gas flow from the low pressure vessel to the high pressure vessel, the entropy of the system (consisting of the two vessels but excluding any external device such as an air pump) would decrease. We can then say that for this system time is flowing backwards, or that the direction of time has been reversed.

Let us consider a simple example of time reversal symmetry. Imagine that a moving train is photographed by a movie camera. Imagine further that, later on, we are observing the film of the moving train. Suppose that for the sake of fun, the projector is run backwards. We will still observe a moving train with the only difference that the engine will appear to be at rear of the train rather than at its front. But this does not represent an impossible situation, for we have all observed trains with engines at the rear during shunting in railways yards. In fact, it is impossible to tell simply by observing the film whether the film is being run forwards or backwards, because the photographer may have filmed a moving train with the engine at its front or rear. This is an example of time reversal symmetry, because a



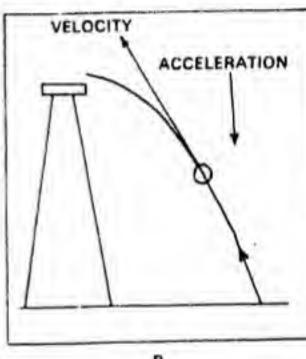


Fig. 2

train with engine at its rear is quite a natural phenomenon; it does no violate the laws of nature.

If a physical process is such that after time reversal, it is again a natural process (that is, does no violate laws of nature), then we say that the process is invariant under time reversal, or it possesses time reversal symmetry. If the time reversed process is impossible to occur in nature, we shall say that the process violates time reversal symmetry.

Let us consider some more physical processes and analyze them under time reversal. In order to imagina a process under time reversal, it is convenient to imagine that a film of the process is being run backwards.

The earth and all the planets mov around the sun in elliptical orbit If the direction of time is reversed they would still move along the same though in an opposite sense. This permissible in nature and hence the volution of a planet around the in is invariant under time reversal.

Next, consider the motion of a

all thrown from the top of a tower.

falls to the ground following a trabolic path. If we imagine this rocess under time reversal, we will e the ball rising from the ground, llowing the same parabolic path of finally alighting the top of the wer. Is this time-reversed process possible? No, it is only a question providing suitable initial conditions. If the ball, when it is on the ound, is given the necessary velocity the proper direction, it will follow the path described. This is shown Fig. 2. Fig. 2(a) shows the ball ling from the tower to the ground,

Coming to elementary particles, has been shown that if a particle essesses time reversal symmetry, it must have electric and magnetic pole moments simultaneously. A article having both electric and agnetic dipole moments would olate T. In fact, so far no elementry particle has been experimentally

nereas Fig. 2(b) shows the ball

ing from the ground and going to

top of the tower.



Vhile they are trying to run time ckwards, our problem is to make ne stay still on us"

Table 1. Effect of C, P and T on various physical observables

Physical observable	С	P	T	CPT
Position vector, r	,			-r
Linear momentum, p				
Angular momentum, L=rxp	L	L	-L	-L
Spin angular momentum s				
Charge, Q	-Q	Q	Q	-Q
Hypercharge, Y	-Y	Y	Y	-Y
Baryon number, B	-B	B	B	- B
Lepton number, L.	L.	L	L	-L
Electric field, E	-E	- E	E	E
Magnetic field, H	-н	H	-H	H

found to possess any electric dipole moment, strengthening our view that T is a fundamental symmetry of nature.

We can imagine a process under CPT as follows. Let a film of the process be taken. Let the film be run backwards (T); let us not observe the film directly but through a mirror, so that a left-right inversion is performed (P); moreover, let all the particles be replaced by their corresponding antiparticles (C). The resulting process will be the CPT-image of the original process. Table 1 gives the effect of C, P and T on various physical observables.

In the case of reactions involving elementary particles, time reversal symmetry would mean that a reaction should be possible in forward and backward time directions. Consider again the β-decay process: n→p+e-+ v. If this process is invariant under time reversal, its time-reversed process should also be possible, that is, we should have p+e+++n. Although this process has not been observed because its probability is small, the associated reactions, such as p+c ->n+v, n->p+c++v, have been experimentally observed. Here it should be remembered that when we transfer a particle from one side of the reaction to the other, the particle should be replaced by its antiparticle.

In the previous article (see S.R. May, 1975), we had seen that some weak interaction processes, such as

β-decay, do not possess the symme tries of charge conjugation and parity, but they are invariant unde the combined operation of CP Later it was found that the decay of the K-meson is not invariant unde the combined operation of CP. Bu since it must be invariant under CPT (according to the CPT theorem), i follows that the K-meson decay i not invariant under time-reversal This has caused a major upheaval in elementary particle physics and many particle physicists are busy trying to understand the significance of thi discovery.

Further reading

- Joshi, A.W., Charge Conjugation Parity and Their Violation Science Reporter, 12, 203 (May 1975).
- Gamow, G., One Two Three... Infinity, Choudhary Bros., New Delhi (1969).
- Baker, A., Modern Physics and Antiphysics, Addison-Wesley Reading, Mass. (1970).
- Adair, R.K., and Fowler, E.C. Strange Particles, Interscience New York (1963).
- Emmerson, M. McL., Symmetry Principles in Particle Physics Clarendon Press, Oxford (1972)
- Physics, McGraw-Hill, New York (1969).
- Eddington, A.S., Nature of the Physical World, Cambridge University Press, London (1928).



FUEL CELLS-THE POWER-PACKS OF TOMORROW

uel cell is a highly efficient, eliable, pollution-free and ilent means of generating lectrical power in remote ocations where other means f power generation are not easible

TUEL cell operates on conventional fuels. It converts chemical nergy of combusion of fuels directly to electrical energy. Unlike a enerator, it is devoid of mechanical arts.

Fuel cell was primarily developed meet power requirements in space. n space vehicles, the payload (incluive of power generation equipment) as to be restricted to a minimum as costs about \$ 1000-5000 to put each lb of a substance in space. Morever, the essential qualities required of device for power generation in space re light weight, high energy density more energy per unit weight), portaility, high reliability and ability to perate without being attended to. fuel cell possesses all these requisite qualities. The most salient feature of fuel cell is its very high energy onversion efficiency.

The efficiency (7) of most sophiticated power plants running on hermal combustion seldom exceeds 10% to 20%. Atomic power plants can attain up to 40%. In these clants energy conversion takes place from heat to mechanical work and s, therefore, governed by a serious theoretical limitation pointed out for the first time (1824) by French scientist N.L.S. Carnot. The energy conversion takes place by transfering heat from a source at higher temperature T_1 to a heat sink at a lowe: temperature T_2 . The efficiency η of such a process is given by the equation

Since T_1 — T_1 is always less than T_1 , the efficiency will also be less than 1. The theoretical conversion efficiency of such a device is very much less than 100%, usually 40% to 50%.

In practice, the efficiency is further reduced due to energy losses at several stages. In contrast, fuel cell contains no mechanical parts. It operates without any temperature change (isothermal process)—converting the chemical energy into electrical energy by direct oxidation of fuel. It does not suffer from the intrinsic theoretical limitation of Carnot Theorem. The theoretical energy conversion efficiency is, therefore, of the order of 80% to 100% and in practice it is quite high, usually 50% to 60%.

The combustion in a fuel cell is a cold process known as 'cold combustion', as there is no burning of the fuel and no heat generation. Here the combusition (or oxidation) of the fuel is carried out

The energy associated with the combustion or oxidation process is directly utilised to generate electron which carry the current, and neactual heat generation takes place. Moreover, there is no emission of any incompletely burnt or unburn obnoxious gases. The danger of pollution is hence eliminated.

In order to understand the princ ple of cold combusion (or oxidation in an electrochemical process, cons der a hydrogen-oxygen fuel cell (Fig 1). This electrochemical cell consis of metal electrodes impregnated wit platinum catalyst and contains electrolytically conducting electrolyt solution. The fuel hydrogen is fe at one electrode and oxygen (oxid zer) at the other. Hydrogen in th presence of the catalyst and electro lyte releases electrons forming H ions, a process represented b equation (2). The electrons as absorbed by the metal electroc which becomes negatively charge This electrode is called anod When the two electrodes are short circuited or a load is connected across them, the electrons start tr velling in the outer circuit from the -ve electrode (anode) to the other electrode. At the other electrod the electrons react with oxygen ar

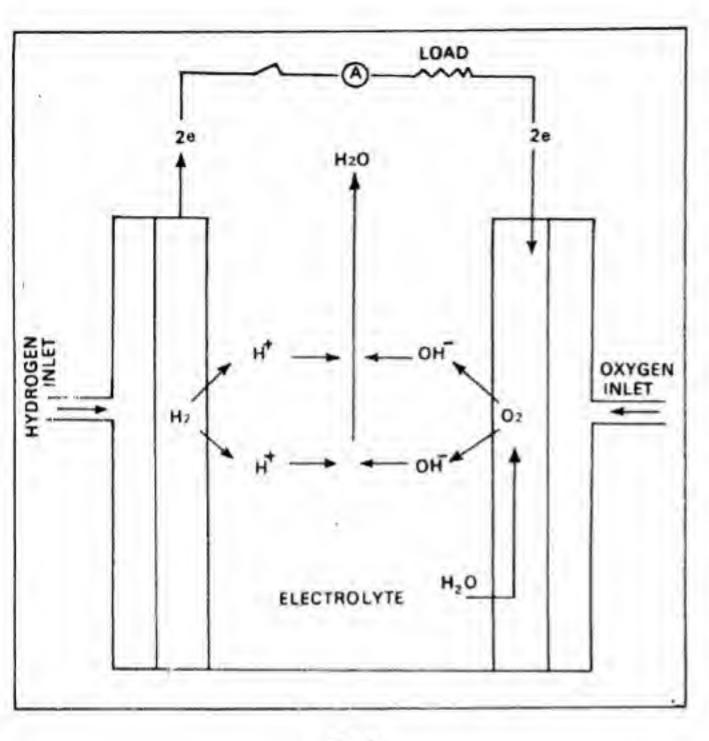


Fig. 1

vater to form hydroxyl ions (OH-). The process is represented by equation (3). Since the electrons are used up at this electrode it becomes +ve. t is called cathode. The scheme of feaction is as follows:

Anode (– ve) reaction $2H_{\bullet} \rightarrow 4H^{+} + 4e^{-}$



'We have produced packs of all sizes and designs to store fuel. The only rouble is fuels are getting scarcer veryday'

Cathode (+ve) reaction

$$O_2+2H_2O+4e^- \rightarrow 4OH^-$$
(3)
followed by
 $4H^++4OH^- \rightarrow 4H_2O$ (4)

The overall cell reaction can be written as

 $H_1 + O_1 + 2H_2O \rightarrow 4H_2O \dots (5)$ The overall reaction involves generation of 4 electrons (or 4 units of electricity), which travel in outer circuit from one electrode to the other to constitute an electrical current. The oxidation of the fuel (hydrogen in this case) takes place just as in chemical combustion. The reaction in the cell is sustained if current is allowed to flow between the two electrodes through an external electronic circuit and if steady supply of oxygen and hydrogen is maintained.

Fuel cell is an electrochemical method of power generation like

batteries. It is, however, unlike storage or secondary battery. T fundamental difference lies in t manner of electricity generation storage batteries and fuel cell. Stora battery discharges on deliveri a discharge electrical current; battery can be recharged, and t inactive materials formed during discharge reaction can be made acti by supplying with electricity. It a reversible system, and a very lar number of charge and dischar cycles can be attained. On t contrary, fuel cell is like a petroleu generator which generates electrici on combustion of petrol. It conver chemical energy of combustion fuel and oxidiser into electricit The combustion process is entire irreversible, for it is not possible produce petrol or fuel by supplying the unit with electrical energy.

Apart from the non-reversibili of combustion process, fuel or differs from storage battery several other aspects. In fuel ce the fuel and oxidant are all gaseou They are contained in and fed fro tanks outside the cell. The fuel ar oxidant can also be replenished. T electrodes do not participate in the reaction but only transfer electro and remain unaffected. In the storage battery, on the other han the active material is contained the cell only. The electrodes tal part in cell reaction and underg reversible transformation.

Fuel cell resembles an unchargeab primary cell in two respects; the or reaction is irreversible, and the electricity generation that takes pla involves oxidation at anode aı reduction at cathode. Howeve some important differences disti guish fuel cell from the primary ce In primary cell, the electrodes ar reactants are solid and not gaseou all are contained in the cell and n fed from outside as in fuel cell. Ele trodes are also consumed during the cell reaction.

The capacity of a fuel cell does not epend on the height and size of the ectrodes, for they do not participate the cell reaction. The chemical vergy is stored in the form of fuel a tank outside the cell. The capaty of the petrol engine generator pends on the quantity of petrol 'tan store, and is, related to nk size. The power output is lated to the rate of energy converon. In a similar manner, the capaty of the fuel cell solely depends on e size of the fuel tank, and the attery size is related to the intended ate-of-conversion or power output.

Systems operating on reactive fuels ich as alcohol, hydrogen, hydrazine, mmonia and natural gas, with xygen and hydrogen peroxide as xidants, have been built and demonstrated. Fuel cells are capable of generating high energy densities usually of the order of > 1.0 KWH Kg⁻¹ The ltimate aim is to develop a low cost onversion device to run on conventional fuels (petroleum, coal or keroene).

pplications

Till now, the fuel cell has played he role assigned to it in space exploation remarkably well. Power equiment in the first Gemini spacecraft ut in orbit for 8 days (August, 965) and subsequently for 14 days December, 1965), consisted of ydrogen-oxygen fuel œll. uel cell also had a self-contained rovision for collecting water-a yproduct of cell reaction for drinkng purposes at a rate of I Pint WH-1. The electric power supplied o main command module during pollo spacecraft landing on the noon was by three independent ydrogen-oxygen fuel cell systems, each delivering a maximum of 2KW and weighing about 91 kg. The power requirements for communication, command and control, guidance, radar, image acquisition, processing and transmission, data handling and storage, experiments on planetery sufrace, life support and exploration vehicle were a provided by hydrogen-oxygen fuel cell.

Terrestrial applications are proving equally promising. In 1966, a firm of Switzerland announced a TV relay station powered by methanol fuelcells. In the same year, Monsanto (USA) delivered a hydrazine fuel cell to American army for advanced military communication. Fuel cells also eliminate the need for central power stations. In April 1966, Pratt and Whitney constructed a 500 W system operating on natural gas or kerosene-air in two packs, each weighing 16 kg, for military purposes. In the target program the same Company in 1971-72 installed 50 units of 12.5 KW natural gas fuelled power supply to bouses in Farmington, Connecticut, as a field trial of small decentralised power units for domestic, commercial and industrial applications.

Technical feasibility of fuel-cell powered clean urban transportation has also been demonstrated. Motors' 'Electrovan' General powered by 32 KW hydrogenoxygen fuel cell (32 modules-Union carbide) can be accelerated to 60 mph in 30 seconds, attain a speed of 70 mph and cover a range of 100 to 160 miles on a single charge. However, power train itself weighed 1660 kg out of the total Electrovan weight of 3228 kg. Power train in a gasolinepowered truck of the same size for comparable performance weighs on 396 kg.

The high initial cost of fuel cell, d to the utilization of expensive nob metal catalyst materials (platinum has restricted its applications power generation in space and remote locations for military whe other means of power generation a not feasible. The running cost base on different fuels, natural gas, pr mium gasoline, ammonia, methano and hydrogen is between 0.2 to 4 cents KWH-1, assuming 50% eff ciency of energy conversion. This quite acceptable, but the initial co may have to be brought down t a considerable extent before an widespread civilian use can be for seen for fuel cell as an economic an efficient means of power generation Further reading

- Rockris, J.O.M., Srinivasan, S. Fuel Cells: Their Electroche mistry, Mc-Graw Hill Book Co. New York (1969).
- & Boon Limited, London, (1972
- Liebhafsky, H.A. and Cairn E.J., Fuel Cells and fuel butterie John Wiley & Sons Inc. No York, (1968).
- Berger, C., Handbook of fuel contechnology, Prentice-Hall, New York, (1968).
- Young, G.J., Fuel Cells, Rei hold Publishing Corporatio New York, (1960).
- Mitchell, W. Jr., Fuel Cell Academic Press, New Yor (1963).
- Breiter, M.W., Electrochemic Processes in fuel cells, Springs Verlag, New York, (1969).
- Chang, S.S.L., Energy Conversion Prentice-Hall, N.J. (1963).



POLYMER SCIENCE-

some recent trends

SWAMINATHAN SIVARAM

New knowledge has been gained to make specific structural modifications in the polymers to eliminate existing disadvantages

ANY of the synthetic polymers in commercial use today are not empletely free of disadvantages. Sientists and technologists have used new knowledge to make secific structural modifications in the olymers to eliminate the disadvanges.

It can be said with a fair measure confidence that the world of nthetic polymers is unlikely to see the near future the development an entirely new, high volume, low st polymer, may it be a plastic uch as polyethylene, polystyrene, olypropylene or PVC) or a rubber tyrene-butadiene rubber, high cis olybutadiene) or a fiber (polyester, rylics, nylons, etc.). If so, it is propriate to ask ourselves: What ture does the world of synthetic aterials hold for us? A look at e state of the art in this area in the ist ten years is indicative of future ends.

evelopment of polymer science

The development of polymer ence can be traced through two

distinct periods. The years between 1935-50 saw the development of most of today's major plastics, fibers and rubbers, such as low density polyethylene, polystyrene, PVC, SBR, neoprene, butyl rubber, polyesters and nylons. The discovery of these was more as a result of accident than of design. The relationship between polymer structure and its property was then largely obscure. For this reason this era is humorously called the 'Hula-Hoop era' in the development of polymer science and technology. In contrast, the next fifteen years (1950-65) saw the development of precisely designed structural polymers such as high density polyethylene, isotactic polypropylene, high cis polybutadiene and cis polyisoprene. This period is more appropriately called the era of 'stereo polymers'.

Since 1965, however, one discerns two general ways in which new polymers have been made:

(a) To synthesize a new monomer which embodies by virtue of its chemical nature some attractive and interesting features. Upon polmerization, one can expect to incorprate these features into polymeralso. Such polymers are designato meet specific applications and a characterized by its low volume as high cost. A few examples of such polymers derived from monomeare indicated in Table 1.

(b) Alternatively, to synthesis new polymers from readily available and inexpensive monomers such ethylene, propylene, butadiene, Veetc., by subjecting them or combination thereof to new polymerization techniques using novel catalyst activators, modifiers, etc.

It is the latter of the two approaches which holds greater promise for the future. A breakthrough he is bound to be within the acceptable cost limits of a new polymer. Consequently, major efforts in the development of new polymers have been concentrated in this area for the patten years.

Multicomponent polymer systems

Polymers wherein more than or monomer is present, bonded eithe chemically or physically, are terme as multi-component polymer system A general classification is outline in Table 2.

If two monomers A and B ar copolymerized, there are four mai theoretical types of structures that can be produced (Fig. 1). Till 196 only copolymerization of two mono mers A and B in a random fashio was known. Since then rapid deve lopment in catalysts and initiator has enabled the synthesis of highl ordered copolymers of the block graft and alternating types. Thes structured co-polymers are often th product of careful design and posses superior technological advantage over the corresponding random co polymers. This will be illustrate using three recent examples from th literature.

. Sivaram is with the Research and Development Division, Indian Petrochemicals Corporation Ltd., Baroda.

etadiene-acrylonitrile copolymers

A random copolymer of butadiene ith acrylonitrile (acrylonitrile connt anywhere between 20-50%) is a seful rubber known as nitrile rubber. his rubber, being a polar molecule, ossesses excellent oil and chemical sistance but has the disadvantage of w green strength (a colloquial term sed for crystallizing property on retching). Pure gum vulcanizates of triler ubber yield poor stress strain operties with tensile strengths in the nge of only 40 Kg/cm². Obviously reinforcing filler such as carbon ack is necessary to improve their nsile properties. Depending on e nature of fillers, a tensile strength high as 250 Kg/cm3 can be obtain-. But fillers also have the dislvantage that they diminish the event and oil resistant properties of trile rubber. In addition, it has en found that higher acrylonitrile ntent in the polymer impoves many the properties of nitrile rubber.

But this also causes gelation (due to crosslinking of polymer chains) and reduces polymer processability, resulting in degradation on milling.

An understanding at the molecular level as to why nitrile rubber possesses low green strength leads us to a solution of the problem. Most linear polymers undergo molecular orientation or crystallization on stretching. With thermo-plastics, such orientation is irreversible. Once the polymer is oriented and quenched, the induced crystallinity is permanent. Some elastomers are also capable of such stress-induced crystallization, but this is temporary. Once the stress is released, the molecule is returned to normal configuration. This is because rubber molecules possess neither large intermolecular attractive forces nor molecular order which will enable them to hold their configuration in unstressed conditions. Those rubber molecules which can crystallize on stretching possess

high green strongth. Examples a cis-polyisopren natural rubber. neoprene and butyl rubber. Other like nitrile, SBR and ethylene-prop lene rubbers, which because of the lack of molecular order are unab to crystallize, possess low gree strength. High cis polybutadiene an anamoly in the sense that possesses low green strength inspi of its ability to undergo stress induce crystallization. It is therefore clea that if molecular order is introduce into an otherwise disordered randor copolymer, we can expect a higher green strength for the former.

Sumitomo Chemical Co. an Bridgestone Tyre Co. of Japan have announced recently the synthesis of a highly alternating butadiene-acry lonitrile copolymer using a new catalyst system (triethyl aluminum aluminum chloride and vanadium chloride at 0° in suspension in n-hexane). The alternating natural of copolymer ensures order in

STRUCTURE

MONOMER

Table 1. Polymers from special monomers

POLYMER STRUCTURE

1. POLY (Phenylene sulfide) -[-\s-]_n	cl -Cl; Na ₂ S
2. POLY (oxybenzoate)	-{o-{	AcO-CO2H
3. POLY (Phenylene oxide)	-[-(CH3)-n	СН3
4. POLY (Phenylene ether sulfones)	-{_>o-{_>so	2

NAME

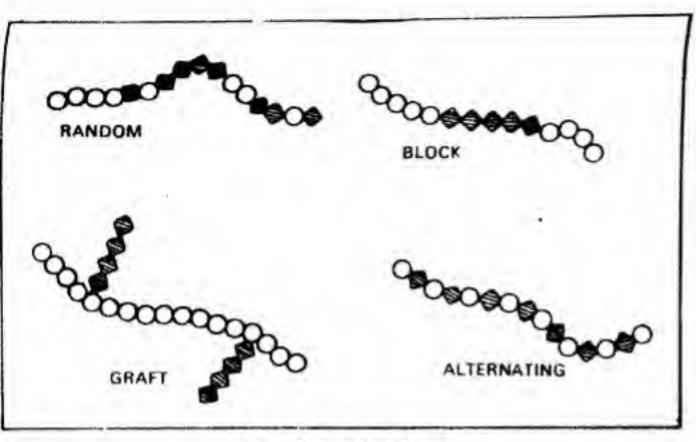


Fig. 1. Types of copolymers

ne polymer causing it to crystallize a stretching. It therefore possesses strength in the gher tensile nfilled state compared to the copolymer. The acryindom nitrile content of the copolymer is 0% and this is achieved with no tendant problems of gel formation. nlike nitrile rubber it can be processon standard roll mills. This aterial is presently undergoing field ials in elastomer and adhesive oplications.

hermoplastic elastomers

Thermoplastic elastomers are marials which 'process like plastics nd perform like rubber' and are a cent entry into the world of synthec polymers.

Synthetic materials can be broadly assified into three major types Table 3). Thermosetting resins of e rigid, flexible and elastomeric

and flexible types are quite well known. The recent appearance of a thermo-plastic elastomer has filled a conspicous gap in the types of available synthetic materials.

Thermoplastic elastomers are based on block copolymers wherein a rubbery polymeric block is sandwiched between two terminal thermoplastic blocks. The thermoplastic block in most commercial polymer is made up of molecules of styrene. The rubbery blocks could be polybutadiene, polyisoprene or any other common rubber. The structure of styrene - butadiene - styrene triblock copolymer is shown in Fig. 2, in which R is the initiator moiety and R1 is the terminating moiety.

These polymers are prepared by solution polymerization techniques using anionic initiators. The monomers are added in sequential order to give the precisely designed polymer structure. In contrast, free-radical pes and thermoplastics of the rigid initiators give a random copolymer

of styrene and butadiene a known general purpose rubber.

The unique property of such rubber is that the need for co pounding the rubber with reinforci agents (such as carbon black) a thermosetting it permanently in slow cumbersome curing cycle eliminated. Further it can be pr cessed on conventional thermoplas machinery.

The reason for this behaviour understandable on the basis of t known microstructure of such bloo copolymers (Fig. 2). Because of the large interchain forces the therm plastic segments form aggregate These are referred to as "domains At normal service temperature the domains are hard and glassy ar therefore they immobilize the tw ends of the sandwiched rubber chai They create a "physical crosslink which is sufficiently strong to pr vent the rubber chain from slipping past each other, a role played l chemical crosslinks in convention rubbers. However, at higher ten peratures, these plastic domasoften, allowing the polymer to flow Such a process is reversible, for o cooling the plastic domains harde and polymer regains its origina properties. Hence, the rubbers ex hibit essentially a thermoplast behaviour.

The chemical nature of the two se ments, their length and weight fration can be varied to give polyme predictable and desirable propertie

Thermoplastic elastomers offer attractive possibilities to both th polymer manufacturer and the end use converter. Thermoplastic ela stomers based on block copolymer are tough, have good low temperatur flexibility, have strong abrasion an chemical resistance, superior weather ability and are capable of bein tailored to desired hardness or sof ness without plasticizers. Consequ ently they can find wide application in footwear, hoses, pipes, automativ goods and tubing and film for medica

Table 2. Multicomponent polymer systems

ngle-phase:	Copolymers		
ulti-phase:	Matrix	Dispersed Phase	Examples
olyblends	Polymer	Polymer	ABS, High Impact Polystyrene
omposites	Polymer	foreign (inorganic)	Glass fiber reinforced plastics

pplications. These elastomers are ydrocarbon soluble, they may be sed in adhesive coatings and . he scaling purposes. An urexplored ield of application is the large scale lending of these rubbers with other olymers to upgrade the performance f low-cost resins. The fact that these lastomers can be processed on tandard automated plastics producon equipment offers bright opportuities to Indian plastic converters. lastic processing is predominantly ocated in the small and medium ector of our industry. Also comared to rubber processing, processng of plastics is more economical nd less cumbersome technically. The atroduction of thermoplastic elastoners will enable the plastic converters use their machinery to produce ubber goods interchangeably with lastics.

crylonitrile copolymers and polylends

Acrylonitrile is one of the most ersatile monomers available to polyner scientists and technologists tolay. It finds extensive use in thermolastics (styrene-acrylonitrile copolyners), fibres (acrylic fibers), elastomers nitrile rubber, acrylic rubbers) and n polyblends (such as ABS).

The presence of acrylonitrile in colymers gives it a high degree of prientation resulting in improved oughness and tensile strength. In addition, the polar cyano group contributes to chemical resistance and petter polymer aging properties. A

Table 3. Types of synthetic materials

Туре	Thermoset	Thermoplast	ic	
Rigid	Epoxy, Phenol-Formuldehyde		PVC Polypro-	
Flexible Elastomeric	Highly Vulcanized Rbbers SBR, cis-isoprone, butadiene	Polyethylene.	. Plasticized P	
	rubber		?	

high acrylonitrile content in the polymer also leads to exceptionally good 'barrier' properties for the material. This means they are highly impermeable to gases like oxygen, carbon dioxide, etc., the gas permeability decreasing almost linearly with increased molar ratio of acrylonitrile in the copoylmer. Consequently it has been recognized that such materials should suit admirably the needs of the food and beverage packaging industry.

But one of the greatest stumbling blocks in the development of high acrylonitrile content polymers has been their 'non-thermoplasticity'. This results as a consequence of their high degree of orientation and thermal instability near the polymer softening temperature. These polymers, therefore, lack fabrication versatility and could not make inroads into commercial markets. However, in the past three years, resins with high acrylonitrile content (about 75%) have been developed which are capable of being processed on existing thermoplastic machinery. The key to the success here has been the development of suitable multiphase polyblends (Table 1) containing acrylonitrile both in the matrix and the dispersed phase. Acrylonitrile

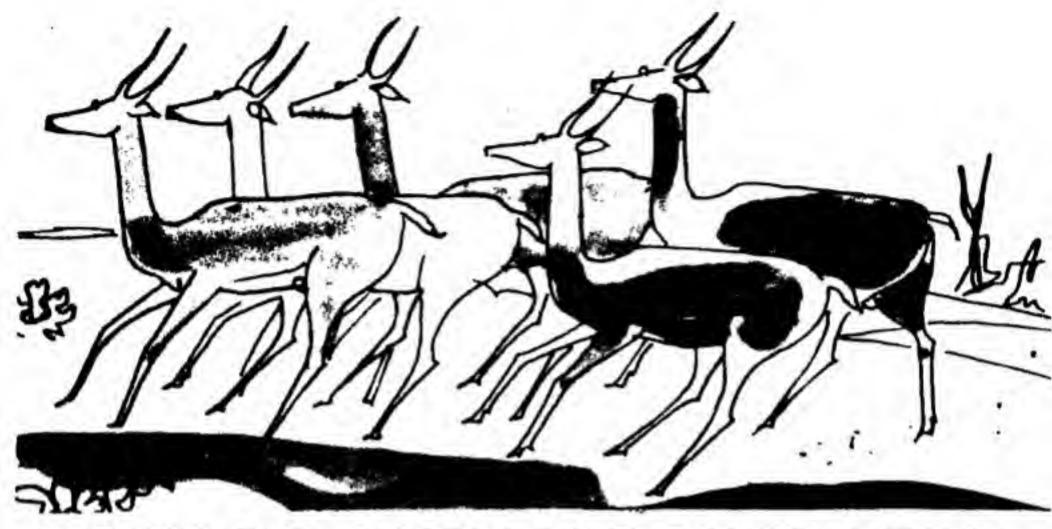
and isobutylene or acrylonitri and methyl acrylate (acrylonitri contents of 70-80%) are gra copolymerized in emulsions with latex of nitrile rubber containing approximately 30-35% acrylonitril The dispersed phases are matched t obtain transparent compositions use ful for the manufacture of bottles an films. These polyblends hav excellent impact strength, barrie properties, chemical resistance an aging properties.

The Indian packaging resin mark is dominated by cellulosics, polyolef films and vinyl chloride films. How ever, when it comes to packaging perishable goods, all these materia leave much to be desired. Cellulsics and polyolefinic films are high permeable to oxygen and carbon dioxide. Films based on vinyl chle ride resins have better barrier prope ties towards these gases. However the recent concern around the wor regarding health hazards posed l the residual vinyl chloride monom content in the film has cast doubt r garding its suitability as a food pac aging resin. Looked from this point view acrylonitrile rich barrier resi offer attractive possibilities in foc and beverage packaging industry.

Conclusion

The incentive for continuing progress through research in polymscience is mainly twofold; (a) economics, and (b) property. Constant search is on for reducing the prices presently available commercial polymers. This can be achieved improvements in existing 'process catalyst efficiency and newer developments in polymer processing techniques.

Fig. 2



WHY DO ANIMALS MIGRATE?

B.B. JANA

derived from the Latin migrara thich means passing from one place another; animal migration means eriodic travelling of a species betteen two localities. All groups of nimals are prone to migration; the irds of northern hemisphere offer erhaps the best known example.

It seems surprising how an animal ands its way from one station to the ther along its route. Scientists have een trying for a long time to know he factors that influence animal higration. It is thought that there exists a relationship between mightion and weather—particularly hanges in temperature.

Migration in birds depends upon vo important factors, guidance and imulus. Guidance during migThere exists a relationship between migration of animals an weather—particularly the changes in temperature

ration is chiefly instructive. In 1949, Gustav Kramer of Germany proved that birds could navigate by the sun. A bird flying south must have the sun at its left in the morning, directly under the sun at noon, and the sun at the right side in the afternoon. Birds keep the position of the sun in mind during migration. While flying at night they are similarly by stars. guided Experimental evidences in artificial planetarium shown that the shifting of the position of the sun causes a change in the migratory pathways.

Heavy clouds or fog, however, inte fere with migration in night.

The north-to-south migrations birds take place under stimulus from the internal conditions of the gonad which are affected by seasonal variations of light. If the gonads undergregression, the urge for migration not felt. Sight plays an importation in affecting the pituitary glan which in turn, stimulates the gonad which then affect the nervous system and bring about the desire to migrate and mate.

Soaring birds such as vulture

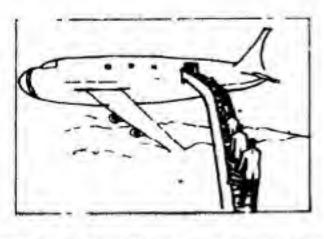
Dr. Jana is presently working at the Ukrainian Research Institute of Fisheries, Kiev-134, USSR.



Attaching a band to the leg of a produtory bawk

nigrate with the help of up-currents. Many birds follow landmarks n the coastal lines, rivers, mountain anges, etc.

Like all characteristics of orgaisms migration too has a genetic omponent. As a rule migratory oirds are smaller in size, mature nore rapidly, lay fewer but larger ggs and are tolerant of environnental fluctuations. During migation in birds, as in the case of nsects, locomotory functions are nhanced but the vegetative functions of feeding and reproduction are uppressed. The available evidence ells that most insect migrations start prior to egg development. In nigratory birds, accumulation of fat called 'high octane' in the body supplies extra fuel during prolonged lights in migration.



"They are all migration experts. So, they are all migrating abroad."

How pigeons home?

THE mystery of homing in pigeons, L like other migratory birds, is not yet solved. Different theories have been put forward at different times. In 1949, Gustav Kramer of the Max Planck Institute for Marine Biology at Wilhelmshaven in Germany demonstrated that birds including pigeons use sun as a compass to determine the accurate direction. But pigeons home even in a heavily overcast weather. Is the sun then essential for homeward orientation of a pigeon released at an unfamiliar site? Williams T. Keeton and his collegues at the Biology Department, University of Cornell, studied pigeon movement in relation to the earth's magnetic field. They conducted experiments in sunny and overcast days on birds carrying magnetic bars and birds carrying copper bars. In sunny days the birds had no difficulty in orientating towards home. In overcast days, the birds carrying magnets usually vanished randomly, whereas control birds with copper of the same size and weight oriented towards home. Similar results have been found by several other workers including Charles Walcott of the State University of

New York at Stony Brook. S magnetic information may play role in the pigeon navigation system Similar influences of magnetic field on European robins by Freidric Merkel and Wolfgang Wiltsch of the University of Frankfurt an on ring billed gulls by William Southern of Northern Illinois Uni versity, have also been reported. Th studies on other alternative means of homing continue. The landmarks as reference points to a homin pigeon, do not serve an importan role in the homing process. The experimets conducted by Schmid Koeing and H.J. Schlichte of the University of Gottingen, by releasing pigeons as far as 80 miles away from home, after implanting frosted con tact lenses over their eyes, showed that pigeons oriented homeward and landed near their homes. Being unable to see the loft they had to be picked up and put into their homes Other studies suggest that landmark play little role in pigeon homing It is concluded that with experience a pigeon learns to orient accurately and that possibly there is more than one compass system for determining direction.

Z. I

Marking practices

In eighteenth century, investigators began the methodical study of animal migration by the various marking practices of the migratory species For example, a leg of a bird (Fig. 1) or a bat is banded or ringed with an aluminium strip or a coloured celluloid band. Sometimes the wings of butterflies are marked with a ticket punch or with a spot of point. Metal discs are affixed to the ears of mammals (Fig. 2) while the metal tubes are shot into the blubber of whales. Recoveries of these marked animals at different places indicate their migtatory routes.

Migratory habits of invertebrates

Various marine snails set ou for migration to rivers in summa and retreat to the ocean in winter Others prefer shallow waters is spring and seek deeper waters when winter approaches. Migrations from marine to freshwater and from water to landmass may probably accoun for the evolution of freshwater an land species respectively. Such a idea is based on the fact that thes freshwater and land species migh have developed from migrants the failed to return.

Sea lobsters (Homarus americanus undertake extensive seasonal mig tions. Their migratory behaviour pears to be motivated by tempeture. Land crabs go to the sea to y eggs. For example, the robber abs (Birgus latro) living in the rious islands of the Pacific and dian oceans can be seen moving eadily in a straight line to the coast nd into the water. After breeding, ec rabs return to thir homes on land. has been found that tagged coastal abs (Cancer magister) travel as far eighty miles in six months. The best nown insect migration is of the onarch butterfly (Danaus plexippus), hich is widely distributed in the orld. It can migrate upto 3,040 Km the fall. By December, swarms of itterflies are often seen flying across e country side from some unknown ace in the north to settle on leaves nd twigs of gardens. In West engal are captured hordes of danaid atterflies such as the plain tiger Danaus chrysippus) and the common ger (D. plexippus) in fields and irdens of Sriniketan. They live ere throughout winter. In a onth's time in April the trees are eserted. In California, where it is ne of the sights of the town, it is timated that 10,000 butterflies mass n five small branches selecting sually the same branch each year.

ligratory habits of vertebrates

Among fishes different species allow different routes; some from alt to freshwater, a few from offnore to inshore, while many others om depths to the surface.

Hilsa and salmon offer the best nown examples of migratory fishes. Indian waters. But all species do of migrate. Only those hilsa which we in the estuaries and in oceans seemd the river water when they feel he urge to breed in the monsoon and inter. The fishes migrate extenvely as much as 1280 Km in the langetic systems and form a subantial fishery in as far north as gra and Delhi. The hilsa stocks

of the Ganga in U.P. and Bihar, however, live always in fresh water without ever migrating to the sea. Similarly, the hilsa in the Chilka lake? whereis a permanent resident of the lake.

Several other fishes migrate much in the same way as hilsa do. Such a travelling is called anadromous migration. In the spring, Atlantic adult salmon travel several hundreds of miles in the river and seek a suitable shallow area where rapid flow aerates the water, necessary for the embryo of the fish. After spawning most of the fish die; a few lucky ones however live to make the special trip back to the sea. The sea lamprey (Petromyzon marinus), an eel-like creature, is another well known example of anadromous migration.

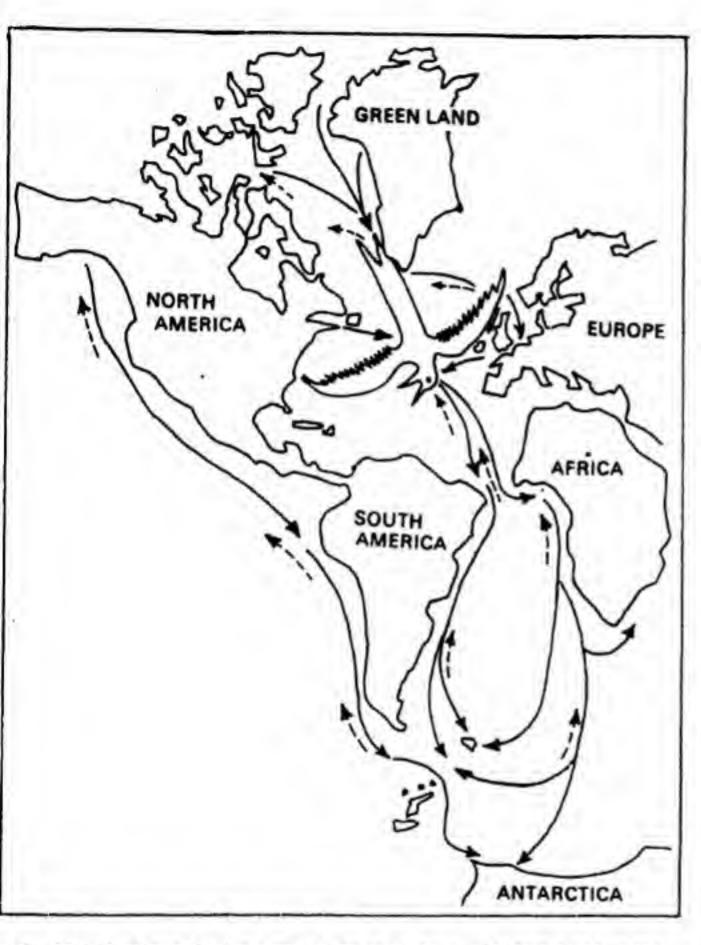
In distinct contrast to that of hilsa, eels exhibit a migration called catadromous. Adult eels live in ponds, of the sea. When about 60 cm long the adults change their body colour and then undertake an extension long journey of as much as 4,800 k to breed in the hot waters of Sargos and Caribbean Seas around We Indies. The American cel (Anguis sp.), after remaining 7 to 12 years freshwater, gets ready to mate. To males and females start their fair journey to the Sargossa Sea to reathere in mid summer. There, after spawning, the parents die.

Amphibians

As the name implies, the amplibians such as toads, frogs, salama ders, newts and their kins lead double life, i.e., they are born in wat and remain there until they had developed lungs to breathe land. Thereafter, they come to the feeding ground on land and late return to the water for breeding



Fig. 2 Marking a mull deer. A metallic disc is affixed to the right ear of the animal while the streamer is attached to the left ear.



g. 3. Map showing migration routes of the arctic terms. The birds hold long distance flight record of 22,000 miles.

fter being nourished three or four ears on land, the virgin newts viriurus viridescens) put on their outh colour and go to water to pulate in the early spring. An teresting example of animal migtion is that of giant salamander of pan (Megalobatrachus japonicus). The adult males in the mid summer ave their natural habitat of deep ountain streams and go upstream a very shallow place of about 1000 ft above the sea level. There by make home by digging burrows the bank and wait for the female

partners. After mating the females go back to their feeding places, but the males return after 2 or 3 weeks to brood the eggs.

Reptiles

All the reptilian migratory species are marine except the huge and long-lived Galapagos tortoises (Testudo elephantopus) which live in the Galapagos Islands off the coast of Ecuador. They exhibit altitudinal migration. These giant tortoises breed in the sandy soil of level valleys in the spring-rainy season. But with the

arrival of dry seasons, they climb to to higher altitudes of 2,000 ft or mo where the vegetation is green. Ne spring, all the tortoises (young ar old) descend to the original place.

Every spring the green sea turtle (Chelonia mydas) leave the ocean are travel up a stream for miles to fin a suitable sandy bank. Similar migration is also known among the seanakes of the sub-family Laticaudina which are common in and aroun Australia. Snakes of the sub-family Hydrophinae, which give birth the living ones, swim in long lines to of fro a breeding place of rocky islets.

Aves

Of all land creatures, birds ar unique for extensive travel becaus of their wings, but all birds do no migrate. Most migrations are lati tudinal, i.e., north and south. Vas land masses and wide feeding zone in the northern hemisphere offe ideal homes to them during summer Winter makes them uncontrolable and so birds move southwards. The long distance migrators therefore are the birds that like cool weatherdefinitely not of the freezing type On the otherhand, birds that nest in warmer areas, as expected, do no migrate.

Most bird migrants, generation after generation, use the established pathways. They arrive and disappear regularly 'according to the calender'. Generally, most birds prefer flock migration bu' migrations in pairs are also seen. Some birds migrate close to the earth and other at heights up to 3,000 or 5,000 ft, but rarely higher. The speed of the 'migration front' averages about 40 km per day, although some individuals fly as fast as 48 to 80 km per hour.

Although we have only a few bird sanctuaries in India, Nalasarovar, a picturesque lake in Gujarat, salt-lake and zoo-lake in Calcutta and some other bird sanctuaries in Rajasthan are considered ideal homes for ou

Magnetic sense organ?

A FEW years ago scientists debated whether or not any organism ould detect a magnetic field as reek as the earth's (approximately alf a gauss). But now there are lues that there might exist a sense rgan in certain organisms to detect he magnetic stimuli. The search for his sense organ has already started t many laboratories including the Department of Biology, University f Cornell, U.S.A. Since the magetic flux can pass freely through ving tissues, the magnetic detecors might be expected to be located ny where inside the body. The uestion as to what a magnetic sense rgan may look like, however, emains unanswered.

Martin Lindauer and Herman Martin of the University of Frankfurt ave demonstrated that honey bees ive orientational responses to magnetic cues several thousand times weaker than earth's field (Scienti-American, December 1974, p. 04). The responses of honey bees magnetic cues now makes us conder if one gamma (10⁻¹ gauss) will prove to be the lowest limit.

The studies William of cecton and his colleagues of the ornell University suggest that the nagnetic detection sensitivity of igeons may rival that of honey ecs. These workers, after a study f over three years, have found that luctuations of less than 100 gamma or probably less than 40 gamma (in he earth's magnetic field caused by olar flares, and sun spots) have a mall but significant effect on the igeon's initial behaviour at the clease site.

Z.I.

vinter approaches, thousands of sulls and flamingos migrate from

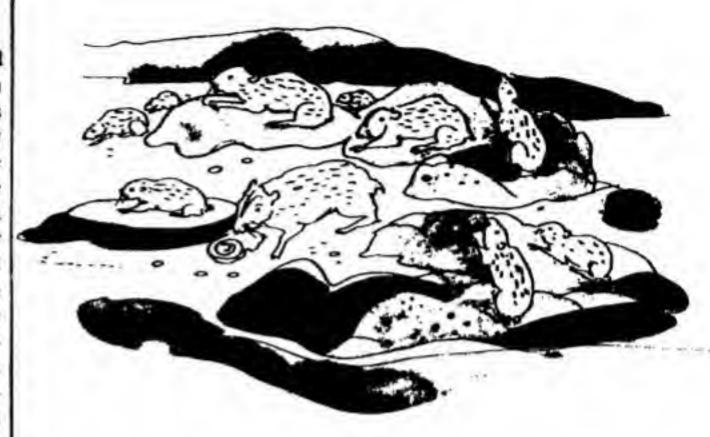


Fig. 4 Learnings at the end of a fatal one-way migration

Manasarovar in the Himalayas to their most favourite lakes and return home in summer. The environmental disturbances, air pollution by factories, profuse use of insecticides on crops, significant changes in the weather condition (like short winters in the last two years) and structural changes in the landmarks, etc., sometimes check their normal flights.

The cuckoo which spends most part of the year in south-east Africa appears in spring in India where it breeds and lays eggs; of course, not in the nest of its own but in the nest of its foster parent, the crow. It is said to cover a distance of as much as 7200 km within a short period.

A surprisingly high record of migration, scoring as much as 35,200 km is held by the arctic tern (Sterna paradisa). This graceful bird builds its nest on rocky and sandy coasts along northern Greenland (Fig. 3) or often around the Arctic Ocean, and spends less than four months in that region. Then it flies eastward to northern Europe and southward along the coast of Africa. Most of these birds cross over to Brazil from Northern Africa and fly down the South American coast to their Antarctic winter range.

Golden plover (Pluvialis sp.) star from arctic Tundra and goes up to to plains of Argentina. Ruff breeds Siberia and travels to Great Brital Africa, India and Ceylon, coveri a distance of 9,600 km. Son birds perform altitudinal migration into mountain peaks for the summand and return to the plains in winter Such migrations occur in roc mountains and the Cascade Sien Neveda systems of Western Non America.

The giant Canada geese (Brancanadensis) forms a characterist V-shaped flock while flying. The have a wide breeding range from Arctic circle to Northern U.S. Son of them nest in Alaska and pass the winter in Japan.

Many water birds also migra for considerable distances. puffin (great shear water bird) breed of small islands and migrate as far Greenland in May and return aft a few months covering a distance 1280 km.

Manuals

-Migration is not so common phenomenon among the mamma tion is furnished by bats. In the othern latitudes as insects dispear in winter, the insectivorous is hibernate in large groups in testone caves or migrate to south variety of bats, viz., red bat (Lasives borealis), larger hairy bat (L. pereus) and silver haired bat (Lasivereus) make regular orth and south trips day and night. It, amazingly, males and females are groups.

Millions of bison (Bison bison) ove north and south with the seams following definite routes. The ge herds of American reindeer angifer arcticus) are still found the deep forests of Canada. Early August they collect in thousands d form somewhat circular gatheres and start a counter-clockwise with eastern migration. The following spring, they return from the oppose direction covering a distance of few hundred miles.

In wapitis (N. American deer ervus canadensis) the onward urney is led by females while back journey by the males bout the middle of September, males and their offspring begin to scend from the high mountain stures, which are later followed in joined by the bulls. All of them inter together in sheltered valleys. It is soon as the snow begins to melt, wards the summer range followed

by females and the newly born calves.

Among the most spectacular mass movements of land mammals are those of the true leadings (Fig. 4). Their movements are interruptions rather than migrations. This mouselike rodent (Lemmus sp.) dwells in the highlands of Norway and Sweden. Over population in them is prevented by a mass movement towards the underlying regions. As they proceed, the animals disregard obstacles in their paths, swim across rivers and even small lakes. Vast numbers are slaughtered by beasts, birds of prey, foxes, cats, etc. Others fall victim to a disease called lemming fever. When the survivors reach the coast they at once plunge into sea and are drowned.

Most whales are inhabitants of cold waters and migrate seasonaally towards warmer waters. The largest of the whales, the blue whale (Sibbaldus musculus), feeds on the plankton in the cold waters of the Arctic or the Anarctic. When ice begins to form, they move towards the tropics where they eat little or nothing. The youngs are born in alternate years. Within a few months, they are able to accompany their mothers back to the polar regions to feed.

Species of earless seals leave the water and spend a breeding season of several months on shore line, but the eared seals (Callorhinus alascanus) find it enjoyable to make a long travel each year. Similar to wapits, the

females and young males lead the journey and spend the winter along the coast of California; the adult males stay further north but join the Californian group in the spring. The pregnant females give birth to their youngs within a few days of arrival Curiously, soon after weaning their calves they again become pregnant and start their home jouney.

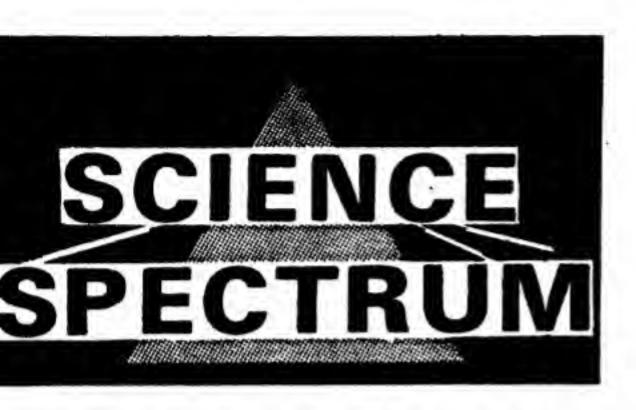
Further readings

- Dingle, H. (1972), Migratio strategies of insects, Science, 17 (4028): 1327-1335.
- Cooper, R.A., Uzmann, J.R. (1971), Migrations and growth of deep sea lobsters, Homarus americanus, Science, 171, (3968): 288-290.
- Johnson, C.G., (1969), Migration and dispersal of insects by flight Methuen, London.
- Dorst, J. (1962), The Migration of birds, Heinmann, London.
- Moreau, R.E. (1966), The bir faunas of Africa and its Islands Academic Press, New York.
- Williams, C.B. (1958), Insecting migration, Collins, London.
- Matthews, G.V.T. (1968). Bir navigation, Cambridge University Press, Cambridge, Second Ed
- Harden-Jones, F.R. (1969),
 Fish migration, Arnold, London
- Walord, L.A., Wicklund, R.I. (1968), Serial atlas of marin environment, American Geogra phical Society, New York.

IT PAYS TO ADVERTISE

IN

SCIENCE REPORTER



Communication by satellites

down to the present, man as achieved much in the field of ammunication. Today, the technology of long distance communication so improved that the whole globe contracted to a point by means of rtificial satellites.

ong distance communication

The working system of long stance communication is mainly four kinds. The oldest is the paxial cable system. It consists of copper tube, 9.6 mm in diaetre, with a single copper wire inductor at the centre; the cables e generally gathered in bundles of to 20. Amplifying equipment must located every three or five kiloetres along the cable depending on the amount of communication affic to be carried out. Indian Post nd Telegraph Department has set up ich systems in several parts of our ountry and is now carrying out such orks along Benares to Cape Comon National Highways of Number even in Tamil Nadu. Coaxial cables ormally carry radio waves with avelengths from 600 to 15 metres.

The second type of long distance ommunication is the transmission of icrowaves through air by means of icrowave radio relay towers, spaced This system exists in many parts of India. Bharat Electronics Ltd. (BEL) has set up an efficient and sophisticated microwave communi-

cation system for police in seve states of our country. The frequen band of microwave radiation rang from one billion to 10 billion cyc per second.

The third transmission techniq is called wave guide. It is not widespread use. It is a simple hollo tube about 5 cm in diameter whi transmits millimetre waves wi frequency ranging from 30 billion 90 billion cycles per second. The technique can carry more communication traffic than the oth systems. The amplifiers in this call are spaced out from 16 to 24 km aparts.

The fourth and newest lost distance communication technique involves the use of artificial satellite. At present, National Aeronautic and Space Administration (NAS) of the U.S. has put into orbit the Application Technology Satellite (TS) from Cape Kennedy, one of the most powerful communication sate

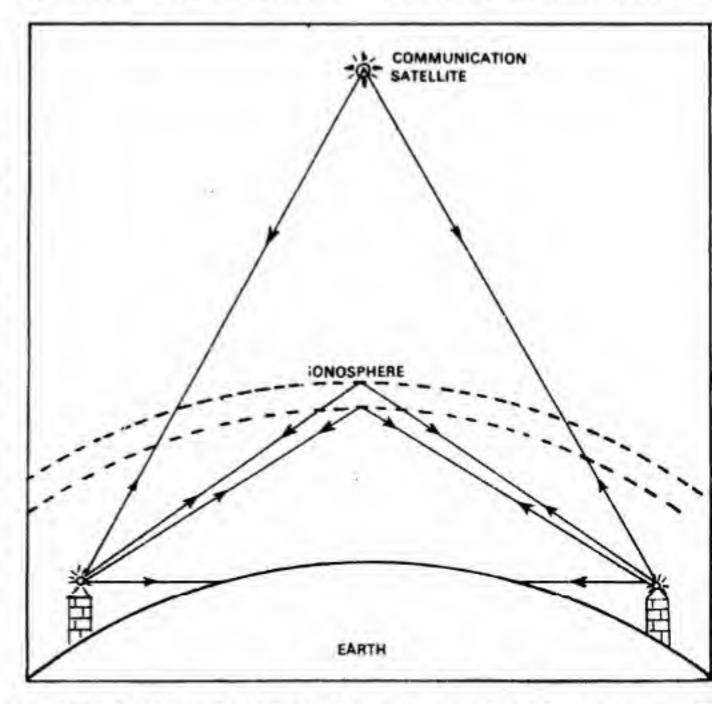
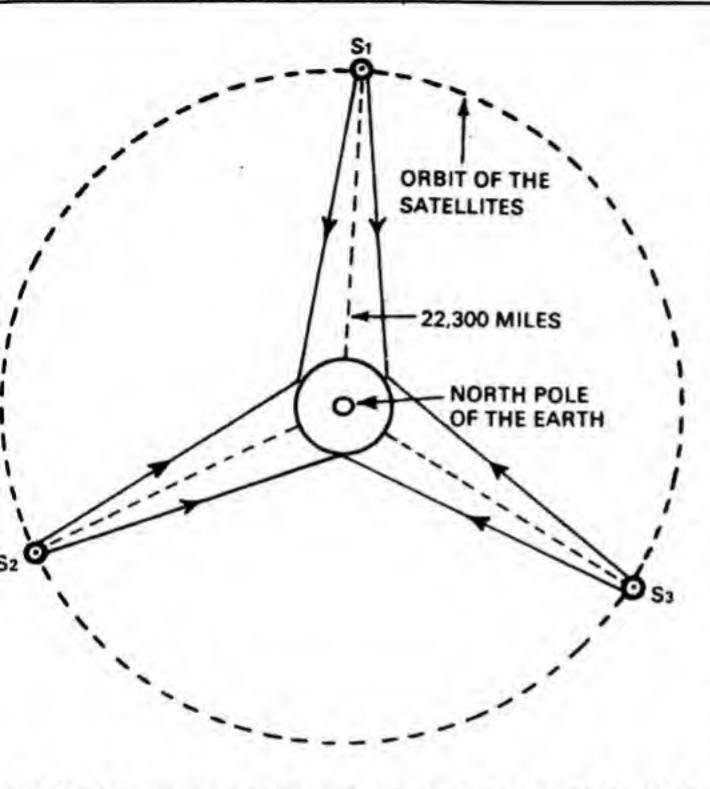


Fig. 1. High frequency radio waves (3-30 mega cps) are reflected by the ionosphere. The higher frequency radio waves (30-3000 mega cps) easily pass through the ionosphere; they are reflected only by satellites. The curvature of the earth severe limits the direct waves.



ig. 2. Three Syncom satellites (stationary) S₁ S₂ and S₃ at the height of 356800 km above the surface of the earth, and uniformly spaced, could cover the globe

tes launched so far. Under some greements with U.S., India is now naking use of ATS-6 satellite rogramme. Communication-wise, his programme, namely, Satellite instructional Television Experiment SITE), is useful for the villages of our country.

reference for satellites

Satellites offer a good solution to he crowding of earth-based channels of communications: wires, cables and vaves. The solid conductor system wires and cables) has been replaced by radio communication (waves). However, this method has the disadvantage that high frequency radio vave (3-30 mega cycles per second)

can travel from one point on the earth's surface to another only by reflections from the ionosphere. Such radio signals are therefore interrupted by ionospheric disturbances like solar wind. Moreover, radio waves of higher frequencies (30-3000 mega cycles per second) are not reflected by ionosphere and so are reliable only between stations in line of sight of each other; these are severely limited by the curvature of the earth (Fig. 1). On the contrary, a satellite, at an altitude of hundreds of thousands of kilometers above the ground, has in its line of sight a considerable area of the earth's surface, and can, therefore, relay signals from one earth station to another without any disturbance.

Because of these facts a satellite preferred for long distance communication.

Communication satellites

Communication satellites are two kinds by design and action namely, passive satellite and activ satellite. A passive satellite doc not amplify but only reflects th incident signal from the groun station. Reflecting part of suc satellites has aluminium coating supported thin plast film. In the case of active satelli there are electronic equipments an powerful antennas which receive th telephonic and radio signals, T.V pictures, etc., and amplify an retransmit them. Communicatio satellites Echo-I and II belong t passive satellite type while ATSover Indian Ocean is an active typ with sophisticated equipments.

Communication satellites can als be classified according to their orbit A satellite that orbits very close t the earth covers up a smaller are compared to one at a greater heigh So a few satellites need be in orb if the height is greater. A satellite at a height about 35,680 km in circular path over the equatoris orbit, synchronises with the rota tion of the earth. Such a satellit is called a stationary satellite. It because the satellite remains in th same part of the sky as seen from th earth. At this height, three un formly spaced satellites may b equatorial or inclined. Moreove depending on the design, size an nature of the satellites they wi either be spin-stabilised or gravity gradient-stabilised or geostationar

Most of the satellites are spherical or drum-like in shape. When the mass of the satellite is uniform distributed about its axis of rotation it becomes both spin stabilized an gravity-gradient stabilized, so that it period of rotation about its ax

emains constant and its axis of rotation keeps a constant slope with the surface of the earth. This trangement helps maintain the same desired orientation of antennas, radiation detectors, cameras, etc., atted to the satellite. A synchronised satellite with the rotation of the earth is geosynchronised and hence as known as a geostationary or stationary satellite.

The power supply necessary to perate the electronic equipment is elatively large. Thousands of solar ells are required for the production of power. Storage batteries are equired for the storage of power for he period when the satellite is in the hadow of the earth. This solar ower supply unit is well protected rom the eruption of ionic flow (solar vind) in the magnetosphere around he earth: otherwise, a heavy flow of urrent due to this eruption can lamage the transistor circuits in the atellite. For example, the command decoders of communication satellite Telstar-I failed after several months. The failure was attributed to the lamage to the satellite transistors by he high concentration of electrons n the region of the magnetosphere hrough which the orbit passed.

The transmission by communicaion satellite is of the same kind as he illumination of earth by the moon, he natural satellite of the earth. The atellites are provided with powerful pherical antennas which receive the elephone, teletype, radio signals and elevision pictures from the earth tation and then send them back to he earth. For this purpose, it uses s sophisticated transponder systems, hich consists of electronic devices or analysing the messages received nd their retransmission (Fig. 3). ome communication satellites, for nstance Relay-I, have two transonder systems as one may fail to work sometime. Each one has enough olar cells to operate 11-watt trans-

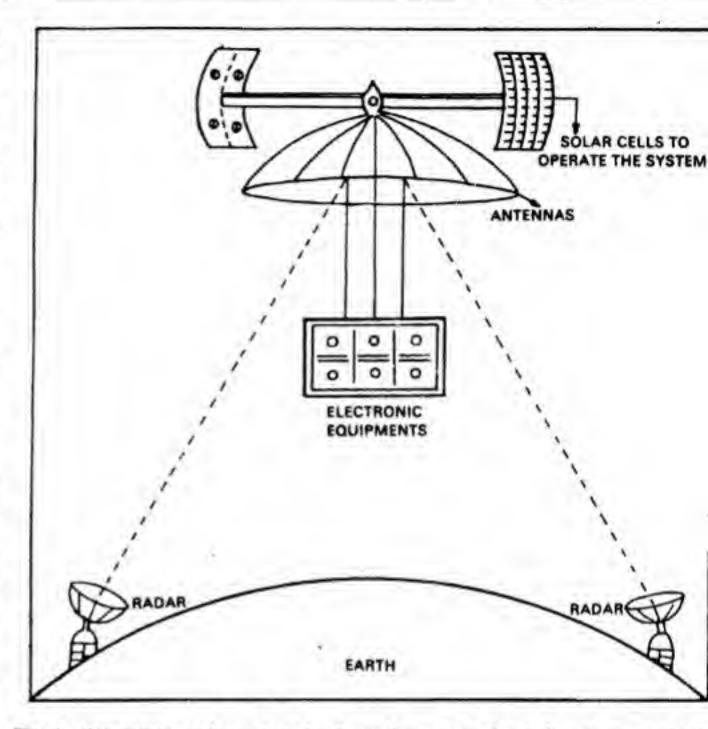


Fig. 3. Transmission and reception of radio or laser waves by stationary communication satellite (ATS) which functions in the same way as the moon illuminates the earth

mitter. Relay-I is designed to handle either 300 one-way telephone communications, or one T.V. channel, or 12 two-way telephone communications. It has efficiently been used for trans-oceanic telephone and television transmissions as well as teletype and facsimile transmissions.

Role of communication satellites

The communication satellites of different kinds play an important and wonderful role in the field of long distance communication. In 1960, the first communication satellite Echo-I was used to reflect and receive the laser signal from the moon, and therefrom the distance between the moon and the earth was accurately measured.

The Early Bird or Echo-II was floated in 1965. It is the world first commercial communication satellite owned by the Internation Tele-Communication Satellite Cosortium and is still operating 35,680 km above the equator at the Atlantic Ocean off the earcoast of Brazil. It receives at transmits television and telephonicalls between North America at Europe.

The satellite Syn. Com.-I had to transponders of different types; of used for two-way telephone conversations and the other for simultaneous one-way telephone conversations well as facsimile and teletype transmission. Syn. Com.-II was used televise the 1964 Olympic games

nom Japan to the United States, and herefore used a different frequency in one of its transponders.

A.T.S.-1, launched in 1966, is a costationary satellite. It rapidly stablished communication with ircraft which need only to choose he correct V.H.F. (Very High Freuency) to link with it. It is also quipped to monitor weather continuously. Because of its position, its reather signals view half the earth. The photographic data by A.T.S.-1 are used for developing mathematical nodels of the earth's atmosphere for nore accurate and long term reather forecasts.

The Comsat Co. inaugurated on 6th January 1967 a commercial ommunication service between the J.S. and the Far East to relay telehone, television and other data. IASA made use of this for the pollo programme. The same Comany has used two satellites over thatic, two over Pacific and one over Indian Ocean. Each satellite as a capacity of 1200 telephone incuits or four T.V. channels or any intermediate combinations.

The communication satellite ntelstat-3, which is of the most dvanced and powerful type, was ent into orbit in December 1969. It is a switch board relay for ommunications between South merica, United States and Canada, Europe, Africa, the near East, India and Greenland.

Satellites have continuously been projected into the space from 1957—irst by Russia and now ten countries, including India. These countries are taken active part in doing so for various purposes, like communication, space research and space ravel. In future each country will have its own pad, big or small for aunching their own satellites of all tinds and spacecraft.

Now different kinds of satellites

are orbiting the earth not only for communication and space research, but also for studies in various disciplines, e.g., biology, communication, geodesy, meteorology and navigation. For space travel, Russia and United States have launched a number of spacecraft, both manned and unmanned. The space just around the earth will continue to be polluted, and so disturbances to the future communication system will increase.

Future communication system

should not only be efficient an economic but also be free fro pollution. So the physicists an engineers have marked off las beam (Light Amplification by Stimlated Emission of Radiation) as the future tool for long distance comminication.

T. MARIMUTE Assit. Prof. of Physi M.D.T. Hindu College, Tirunelveli-Tamil Nac

Discovery of monopole doubted

N August 14, last year, the University of California at Berkeley and the American Institute of Physics in New York jointly announced the discovery of a particle representing the basic unit of magnetism (S.R., September, 1975, S.R., Feb., 76). It was called magnetic monopole, since it exerts a magnetic force of only one polarity: north or south. Normal magnets are bipolar. This discovery was greeted as "one of the major scientific events of the century." Immediately upon the publication of the evidence in support of the discovery in the Physical Review Letters (August 25, 1975), some doubt was cast on its validity because of some incorrect information about experimental apparatus. While Dr. P.B. Price of the University of California, who headed the team that reported the discovery, argued the validity of the discovery, other prominent physicists challenged validity. Observation of the particle had been made with a massive stack of plastic sheets, emulsion and other detectors suspended from a balloon over lows to detect high-energy particles or cosmic rays from space.

Considering the various properti of the detectors, it was concluded b Dr. Price and his colleagues that or particle tract that had penetrated th entire array could have been le only by a monopole passing through it. Now it is known that the thick ness of the material penetrated b the particle was too great for suc a conclusion. In fact, the wide of the detectors was thinner that described in the discovery report This discrepency in the width of the detectors leads to other conclusio as Dr. Luis W. Alvarez, Nobel laur ate of the same Berkeley campus the University of California, suggest that the particle was a platinu atom that, as it passed through t stack of detectors, broke into osmium nucleus and then into tantalum nucleus. Dr. Price, co ceding the error in the width of t detectors, said that it did not inva date his conclusion. Further inves gation is now under way to reexami the whole experiment.

> R.K. DAT Beth Israel Medical Cen-New York, N.Y. 100

Parity non-conservation and weak interactions

TOW do we designate our right and left sides? Although the uestion sounds simple, to find a litable rejoinder is not an easy sk. The distinction of left side om the right side is anybody's uess. Perhaps it is the first lesson a child in his acquaintance with is vast nature. Yet a good scientitheory, which could explain such naive concept, was to remain explored for a long time till Profs. sung Dao Lee and Chen Ning Yang, o Chinese physicists working in S.A., gave a relevant theory in 56, which subsequently obtained r them the Nobel Prize in physics 1957. They discovered that the ft-right symmetry, which is valid most of the interactions that occur nature, is completely invalid in the main of weak interaction.

mmetry

In order to view the phenomenon early, first we shall have to know hat symmetry is. A pattern is mmetric if its right side is an exact production of the left side, or vice rsa. Also, an object is symmetrical there is something we can do to it id after doing that we can't find by change in that object.

Nature loves symmetry. Most of a objects found in nature have rious types of symmetries. Perhaps a most common symmetrical object a sphere, and majority of objects and in nature are spherical—for ample, from the tiny dew drops to ars, planets, etc., all display spherisymmetries. Also the crystals and in rocks have various types of mmetries. Our body has a kind symmetry, i.e., bilateral symmetry: Let us now imagine a girl standing

in front of a mirror. According to the definition of symmetry given above, there should not be any means to distinguish the girl from her mirror image. However, from our everyday experience, we may say that, what is seen on the right side of the girl would be transferred to the left side of the mirror image. If the girl in our observation wears a wristwatch on the left wrist, the image would have it on the right wrist which ultimately distinguishes the girl from her mirror image. But according to physics, the concept of symmetry is much more wide than as described here. To wear a wrist watch on the right hand is not a difficult job, that is, the mirror image in this case is not an impossible event. Therefore, the events in both sides of the mirror have counterparts in our real physical world, which is an essential condition for symmetry between the object and the mirror image. However, there is a serious question which physics has to answer: Is that all we see in a mirror possible in nature? Here physics must say 'yes' if it has to keep symmetry valid. But as we have seen, if we take a watch or an open book before a mirror, we find something unusual. The hands of the clock move anticlockwise; the scripts in the book or the numbers indicating time in the watch look like something which we never use in practice (Fig. 1).

A moment's reflection, however, reveals that the problem we have just encountered is a matter of convention only. We are in habit of using clocks whose hands rotate clockwise. But to make a clock with the hands rotating anti-clockwise and whose performance is otherwise

normal is not impossible. The sai is true for the type of scripts. The may exist some civilization who writings are just our mirror scrip In physics, this type of symmetry described above is called paris Previously it has been accepted f a long time that, like energy as momentum, parity is also conserve in all physical processes, so to sa physics shows complete symmet and right-hande hetween left systems. This is known as Mach principle.

The conservation of parity w first observed by O. Laporte in 192 while studying the energy levels complex atoms. Later in 1927, E. Winger gave a significant interpret tion of Laporte's observation, ar stated that the conservation of paris is a direct consequence of left-rigi symmetry. In this manner, the con servation of parity was given a war reception in physics as a basic la of nature, and was applied to sever fields of physics, notably in nuclea reaction, meson interaction, β-decay strange-particle physics. In som cases, however, the law is foun unsuitable, as discussed below

Tau-theta puzzle

The confounding part of the dram began when two giant particle accelerators in the U.S.A., the Cosmotron a Brookhaven and Bevatron at Berkele



Fig. 1

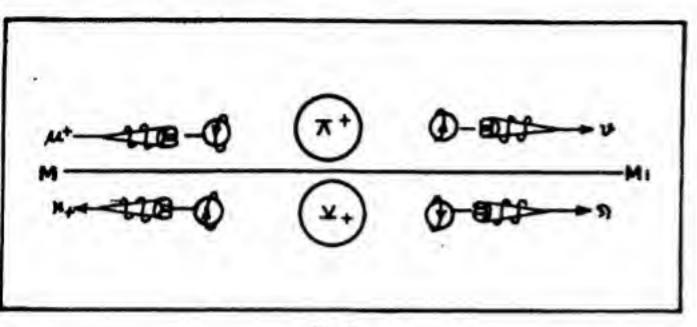


Fig. 2

oduced some K-mesons which eatly embarrassed the physicists. ney called it 'Tau-theta puzzle'. ne K-mesons so produced displayed me queer behaviour. Some K-esons were found to decay in the llowing mode

k⁺→π⁺ + π⁻ + π⁺
hich were called τ-mesons, while
hers were found to disintegrate as

k⁺→π⁺ + π^o

d were called 6-mesons. and 0 mesons have equal masses. he life-span of the two particles iring which they disintegrate were so found to be equal. This and a ost of other experiments led physists to conclude that the two particles e identical. Now the puzzling estion is: How a particle could cay at one moment into an even rity state, while at another into an ld parity state? It may possible that the decay interactions do not nserve parity. But then the law parity conservation had such a m basis that nobody dared to estion the validity of this law in ysics. The challenge was taken up by Profs. Lee and Yang. They began to scrutinise in detail all the experimental knowledge gathered regarding parity-conservation.

There are four types of basic forces or interactions known to exist in nature. These are given in the Table 1 below. Except weak interactions, Yang and Lee found impressive evidences for the validity of parityconservation in all other cases. In weak interactions lot of information, obtained mostly from experimental observations, was available. But nobody, however, had ever tried to verify the validity of parity-conservation in the case of weak interactions. These weak interactions are responsible for the slow disintegration of elementary particles, e.g., B-decay, muon decay, pion decay, etc. After a detailed study of the weak interaction processes. Drs. Lee and Yang boldly declared that parity in this process is not conserved.

Beta decay

This phenomenon essentially con-

Table 1

Class	Strength
Nuclear force, which holds protons and neutrons inside the Electromagnetic force, which holds the atoms to form a molecule. Weak interactions, which arise in radioactive decay. Gravitational force	10-4 10-4 10-4 10-4

sists of the emission of electrons (positrons) by a radioactive nucleu The process has some resemblance the emission of photons by an ator There are no photons in an aton a photon is created from vacuum an atom makes transition from or energy state to another. In a similar manner, a nucleus does not conta electrons, they are created in β-deca process. The emission of electron in this process is also accompanie by the emission of another partic called neutrino (v). In the proce of B-decay, a nuclear neutron (transforms into a proton (p), a electron (e-) and antineutrino (v)

n → p + e⁻ + ν

Similarly, the emission of positron in β-decay should be considered the transformation of a proton (p into a neutron (n), a positron (e and a neutrino (ν):

p → n + e⁺ + υ

This β-decay process was chose to perform the crucial test of determining the validity of parity-conservation. Radioactive Co⁺⁰ was selected for this purpose.

Co60 experiment

National Bureau In the Standards in U.S.A., Madam C. another Chinese physicis and her associates (Ambler, Haywar Hoppes and Hudson) performed th remarkable experiment, and dete mined the asymmetry observed the emission of 8-particles. Th main theme of the experiment was line up the spins of the β -emitting nuclides along the same axis, and determine whether the same numb of \$-particles were emitted in both directions along the axis. In ord to prevent disruption of the order orientation among the nuclides di to the thermal agitation, the cryst was cooled to an extremely low ten perature (only 0.01°C above the a solute zero). It was found th most of the β-particles were emitt the direction opposite to that of the nuclear spin. Therefore, Wund her associates concluded that the the viewpoint of β-emission, the Co⁶⁰ nucleus has an intrinsically left-handed spin. The presential direction of the emission of ectrons, i.e, the up-down asymmetry this experiment proves beyond bubt that left can be distinguished om right, which finally overthrows arity from the weak interaction of physics.

The significance of the above reilt may be explained in the followg manner. Fig. 2 indicates the
sintegration of a #+ meson into
#+ meson and a neutrino. Acording to the conservation of angur momentum, the resulting two
pricles must spin in opposite direcons. Now it is known that the
dicity of a neutrino is negative;
high means that an imaginary dot
ark on a neutrino would advance
would a left-handed screw. The

helicity of an autineutrino is positive, which means in this case the dot mark advances as a right-handed screw advances. When the $\mu^+ - \pi^+ - \nu$ reaction is observed in a mirror MM₁, the observed image could never be made to occur in reality. In this image, the helicity of a neutrino is found to be positive which the nature forbids. Hence, in this case, the symmetry is found to be lost which was frantically sought for so long.

Many observations of this type have been made so far, e.g., the disintegration of a μ-meson into an electron and two neutrinos, the decay of Λ-particle into a proton and a τ- meson, the disintegration of Σ-particle, etc. All experiments are good evidences in abolishing left-right symmetry in weak interactions.

TAPASH CHAKRABORTY

Deptt. of Physics

Dibrugarh Univ.,

Dibrugarh-786004

of acoustic waves. The frequency a sound wave is characterised by definite wavelength. The velocity propagation of ultrasound (u), the wavelength (λ) and the frequence (f) are related as

$$u = f \lambda$$

The upper limit of the frequency of ultrasonic oscillations obtained so fa is around 10° Hz. In air, for ultrasonic waves of frequency of 10° Hz the wavelength corresponds to about 30×10-4cm. The wavelength of light rays in the visible region lie in the range of 4 to 8×10-4cm. Hence, ultrasonics with such sma wavelength resemble light waveland so the laws of geometrical opticare applicable to it.

Types of ultrasonic waves

Almost any material that ha elasticity can propagate ultrasoni waves. As the ultrasonic wave passe through the medium it causes specifi movements in the elements of th medium. Depending on the direct tion of the movement, the propagate wave is termed as longitudinal of transverse or shear waves. Since the oscillations of a particle in th elastic medium take place in th direction of the restoring force i liquids and gases, a wave can b propagated only in the direction of the oscillatory motion of the particles i.e., only longitudinal waves can b propagated. In the propagation of such longitudinal waves there aris in the medium successive regions of compression and rarefaction. I solids, both longitudinal and trans verse waves can be propagated. I a purely transverse wave, compression and rarefaction of the medium do no occur. Any of these types of wave may be continuous, modulated o pulsed. The pulse, for example consists of a short train of wave through the medium. The mos common example of a pulse, ofter

Basic aspects of ultrasonics

TLTRASONICS is the name given I to vibrational waves of a freency above the hearing range of the rmal human ear (above 16 kHz to kHz). The study and applications ultrasonics is broadly divided into o sections, one dealing with lownplitude (i.e., low energy) vibrations d the other with high energies. the propagation of ultrasonic aves of low amplitude the medium es not undergo any change permantly, rather it affects the wave opagation. In high-energy applitions, on the other hand, the waves ing about a permanent change in e medium through which they pass. Techniques based on low-amplide waves are utilised in thickness

measurements, determination elastic constants, flaw detection and instrumentation (like the design of delay lines for computers), etc. Ultrasonic cleaning, drilling, chemical processes and the production of emulsions are examples of highenergy wave applications. Frequencies of 10-100 kHz are used for industrial applications like sound ranging, submarine signalling and communication. Frequencies of 10 kHz to 20 mHz find use in testing materials for flaws, chemical treatment, medical therapy, etc.

Ultrasonic oscillations

Presence of a material medium is a necessary condition for transmission

162

sed, is the one in which it builds up apidly and decays exponentially.

Plane, cylindrical and spherical aves are distinguished by the nature f their trajectories of propagation. purely spherical wave is one prouced by a point source, and which preads out uniformly in all direcons. The control of wave direcon being very important, such aves are rarely used in practice. hey are used only in certain speciised applications and in theoretical onsiderations of ultrasonic effects. practice, if the radius of the raditor (r) is small in comparison with he wavelength (λ) of the sound diated by it, a spherical wave ccurs. At a given frequency, with an crease in the radius of the transducer e spherical wave transforms into plane wave. So, if \(\lambda \) is small in omparison with r, a plane wave will ccur. A plane wave is the one hose amplitude over a plane, perendicular to the direction of propaation of the wave, is uniform. Both ne size of the vibrating area and the istance that the waves have travelled fluence the shape of the wavefront. ienerally the wave becomes more early plane as the distance of travel icreases.

As the compressions and rareactions at every point of the medium,
ay a gas or a liquid, occur during
the ultrasonic propagation, heating
and cooling take place. But as the
thermal conductivity of gases and
quids is small, the temperature
uctuations cannot penetrate the
urrounding medium, and effectually
there is no exchange of heat.

Ultrasonic waves are reflected in everal ways depending upon the ature, size, shape and orientation of the obstacle. The relation of the vavelength to the size of the obstacle tems to play an important role. If he surface is flat and large with espect to the wavelength, the reflection is essentially specular. A flat

surface may be considered as one where the irregularities are greater than 1/20x. When the surface is irregular, the energy is broken up and reflected haphazardly. If the obstacle is very small, e.g., only a small fraction of a wavelength, there will be no real reflection. The ultrasonic waves in such a case pass around the obstacle and come together behind it as though there were no interference. Obstacle in such cases may also be small bubbles, air pockets or impurities in an otherwise uniform solid medium. If there are enough of small inclusions or obstacles, a large proportion of the energy may be scattered without any reflection and the energy will merely disappear within the medium. This is similar to the scattering of light by dust or fog particles in air. Diffraction of ultrasonic waves also occurs analogous to light waves.

Beaming effects

Ultrasonic waves propagate through a medium with very little divergence, provided the source of vibration generates pure sine waves (waves with transverse vibrations of a simple harmonic type). But in reality this condition is not completely realised and there is always some spreading. The spread is a function of the ratio, $\frac{\lambda}{D}$, where λ is the wavelength of the ultrasonic wave and D is the diameter of the source. With a circular quartz crystal transducer of planar form the energy is located in a cone having its half angle of spread, A, given by

Sine A = 1.2
$$\frac{\lambda}{D}$$

The way in which a crystal is mounted affects its beaming characteristics by restraining the edge. Vibrations at the edges produce secondary beams but normally they are of little significance.

Ultrasonic velocity

Measurement of ultrasonic velo-

cities in liquids are comparative easier than in gases. The cryst transducers and liquid media do not differ much from one another, sthat a good acoustic coupling is easi obtained. However, when electroly solutions are used, care is taken that there be no possibility of shor circuiting the transducer electrode through the solution.

Three methods of measuremen

are mainly used. The optical diffrac

tion method is based on the princ ple that a parallel beam of ultrason waves in a transparent medium ac as a diffraction grating for ligh For a stationary wave system, th periodic variation of refractive inde produces a grating with a spacing of $\frac{\lambda}{2}$, where λ is the acoustic wavelength For a progressive wave system, th grating has a spacing of \(\lambda \) and moves with the speed of sound The speed of sound, however, negligible compared with that of light, and hence the grating is virtual stationary. This method possesse the distinct advantage that the ultra sonic field is not disturbed by the of bodies (such a insertion

detectors) into the wave pattern. The interferometer method is use for liquids and gases. An ultra sonic interferometer is based on th principle of reflection of waves bac to their source by a plane reflecto By moving the reflector resonance are noted. These can be studied b recording the sudden changes in th current that flows in the electrical parts of the detector system. Inter ferometers can be of fixed path of variable path type. For liquid particularly when they are coloured a variable path interferometer suitable.

In the pulse technique a short train of ultrasonic waves is sent through the medium to a receiver. The receiver is placed at a measured distance from the source. From the me of travel of the pulse and the coustic path length, the speed of and in the medium is determined. With the exception of water, for all quids the ultrasonic velocity decreases with increasing temperature, water, with increasing temperature the velocity of sound increases it reaches a maximum at a tempeture in the range 75—85 °C and then creases. With increasing pressure e velocity of sound increases almost nearly.

Investigations have established that aqueous solutions of electrolytes, e velocity of sound is approximately linear function of the concentration. he ions of a strong electrolyte when ssolved in water orient the water olecules in their immediate vicinity cause of the strong electric field ound each ion. The increased essure near the ions leads to a arp reduction in the compressility. The ion with the solvent olecule has, therefore, zero coeffint of compressibility. The prence of such incompressible spheres ids to an over all decrease in the impressibility coefficient anifests as an increase in the locity of sound. This fact is used determining the hydration imbers of ions.

sorption of ultrasonic waves

Attenuation studies with ultranic waves yield valuable inforation about the physical properties the medium of propagation, esorption due to scattering can dicate factors such as grain size polycrystals and the densities and tes of aerosols and hydrosols.

When an ultrasonic wave passes rough a liquid medium, during the sitive half-cycle (stress), energy is sorbed, and during the negative lf-cycle, energy is given up. For is exchange of energy a finite period time is required, which depends on e exact processes occurring in the medium during the half cycles. This phenomenon leads to absorption of energy due to a time lag in energy exchanges between the neighbouring molecules in the liquid, and is known as relaxation absorption.

In associated liquids similar to water—the alcohols, glycerol and other liquids with large intermolecular forces, the excess absorption has been shown to be caused by structural or volume relaxation.

Sonoluminescence

Of all the effects associated with the passage of an intense ultrasonic wave through a liquid, the production of cavitation is probably the widest known but the least understood. The action of cavitation in a number of liquids has been observed to be accompanied by a luminescent effect.

A weak glow is observed near an air water interface and in a standing war system. It has been observed th luminescence occurs in the present of oxygen or nitrogen in solution form, and that intense luminescenoccurs in water at temperatures ner the freezing point, disappearing altogether above 40°C. Quant tative estimations of the intensi of luminescence produced in a nun ber of different organic liquids has shown that the luminous intensity proportional to the product of dipo moment and the viscosity of the It has been established liquid. however, that luminescence does no occur if cavitation is absent.

C.V. SURYANARAYAN

J. KUPPUSAN

Central Electro-Chemical Research

Institute, Karaiku

On Public Language programming

I TIGH level computer languages I are developed to take advantage of the capacities of the powerful computer systems, that are now being developed, to make programming easier for the users and to establish an effective man-machine communication. It is with these objectives that PL/1 (Public Language/i) was developed in 1964 by IBM, one of the pioneers in the computer field. PL/I is the most versatile computer language that has been developed so far and its features provide a range of application not possible to any other single language. Whereas Fortran and Algol are specially suited only for scientific applications, Cobol only for business and commercial applications, PL/1 aims at breaking the barrier between commercial and scientific languages by providing a single unified language

suited for all purposes. Some of the salient features of PL/1 can be summarised as follows:

"Catering to the novice" is on of the most attractive features of th PL/I language. A programmer ca use the language at his own level of experience and need not know th most sophisticated features of PL/ option Every 15 given 'default' interpretation, that would most useful to the pro grammer who is ignorant of the existence of the option. For ex ample, if one writes a program as PUT DATA (A, B), where may be a decimal number of value 0.00004 and B may be an intege number of value 275. The PL/ compiler has built-in provision to give the results of A and B in appropriate to the format most If specific instruction situation.

ROW 12 ROW 11 B - 5.0, C = 3.0;

Fig. 1

ny other format, the same will be applemented. The compiler option implemented only when the promammer has not given his option or the output of the result.

Unlike Fortran and Cobol no secial coding form is necessary for riting PL/1 programs. The program in be punched anywhere between olumns 2 and 72. Statements can gin at any column and even two more statements can be punched a single line (card), or more than ne line (card) can be used for inching a single statement. Every atement is terminated by a semiolon and this is the indication to e compiler that the particular atement is over. Absence of undue strictions in PL/1 reduces punching rors considerably.

A beginner need not specify any tributes to the input data, such as inary or decimal, fixed or floating oint, real or complex, numeric or naracter, and so on. The PL/1 ompiler, as we have said earlier, is ighly sophisticated. It will scan he data and will give the appropriate tribute suited to the situation. In ther words, the compiler ascribes by efault those attributes that are most kely intended by the novice programmer. The output is always

given in a fixed format when no attributes are specified. All the same, an expert programmer can make effective use of the highly extensive I/O (Input/Output) facilities available in PL/1.

Mixed radix (binary or decimal) and mixed scale (fixed or floating) arithmetic can be done without much trouble to the beginner. PL/1 treats the error rather kindly. Besides- a few restrictions and regulations, the program will either automatically correct, or indicate at the time of compilation or testing the user's minor errors.

PL/I words formed to name variables and constants are called "identifiers". There are certain words called "key-words" which have designated meanings in the language. For example, words like PROCEDURE, DECLARE, DECI-MAL, FIXED, OPTION, GET, DATA, MAIN, END, IF, GO TO etc., are key-words in PL/1. There are key-words in Fortran and Algol also, but the languages do not allow the key-words to be used as identifiers. PL/I has more key-words than Fortran or Algol, for it expresses a much wider variety of operations. It would be contrary to the philosophy of PL/1 if the programmer has to learn all these words whether therefore, allows the programmer to use the key-words as names for his own use. For example, the world if can exist in the same program both as a variable or as a key-word. Although PL/I permits key-words to be used as identifiers, a sound programming practice avoids using them even when one is aware of the keywords.

PL/I language is modular in th sense that with some minimum rule a beginner can write a complet program for a small problem. Thes rules form a part of a big se of rules used for writing comple programs. In other words, whe new rules are added, the old rule are not abolished and the laguage is built with the old rules forming a part of the big language structur Therefore, because of the modula structure of the language, a larg number of subsets can be develope for different uses without knowing what else is available in the tot language.

Procedures

Every PL/I program is called PROCEDURE. A procedure mu be in the following form:

label: PROCEDURE OPTION (MAIN); (all other state ments which make up the program)
END label;

ust like numbers given to Fortran atements, we give some label r name to PL/I statements. When statement is labelled, a colon mark placed between the label name and ne statement. The statements are ter referred to by their labels and ot by numbers. The statement ROCEDURE OPTIONS (MAIN) ill always precede all other program atements. The END statement just be the last statement of the rogram. There may be several produtes in a program However, nere can be only one main procedure. Il other procedures are similar to ibprograms in Fortran and they ust occur only in the middle of the ain procedure.

typical PL/1 procedure

Let us now write a PL/1 procedure sing a subset suited for the beginners. the problem is to find the roots of quadratic equation $AX^3 + BX + C =$, when A = 2, B = 5 and C = 3.

/*PL/I PROGRAM FOR FINDING THE ROOTS OF A QUADRATIC EQUATION*/ ROOT: PROCEDURE OPTIONS (MAIN);

GET DATA (A, B, C)
D = SQRT (B*2-4*A*C);
X1 - (-B+D)/(2*A);
X2 - (-B-D)/2*A);
PUT DATA (A, B, C, X1, X2);
END ROOT;

ne first statement is a comment interest. The programmer can it remarks or comments anywhere the program by enclosing it within and */, and it is not translated the compiler.

It is meant for the readers to derstand the different steps in the ogram. The label "ROOT" is a name of the procedure. The me label must be referred to in the

END statement as shown above. Even if the programmer forgets to give a label for the PROCEDURE, the compiler will use its default option and assume its own label for the procedure and proceed with the compilation. The next statement corresponds to the READ statement in Fortran. The statement simply reads GET DATA (list), and there is no formatting, no declarations and no editing. Simply punch the data in the card in any column one likes as shown in the Fig. 1. By using this GET DATA statement one can read the data into the computer for further computation. It does not matter in what order the names and their values appear in the card, since the card contains the variables' names as well as their values. Commas must be used for separate values, and the set of data must be terminated by a semicolon. The next three statements are Fortran-like statements which effect computation.

Once the computations are over, or would like the results to be printed. This is done by the statement PUDATA (list). The Put Data statement produces an output somewhas follows:

A = 2.000E00 B = 5.000E00, C = 3.000E00, X1 = -1.000E00, X2 = -1.500E00;

The results are given in E Forma So we see that the I/O statements as so simple—they need no declaration or format statements as in Fortras This is known as the Data Directed I/O and it is, obviously, the simples Of course, this program uses the simple subset meant for the beginner

With such overwhelming advantages in its favour, PL/1 is bound to reign supreme in the computer world for some more years to come.

R. RAMASWAM Lecturer in Physic Thiagarajan College of Eng Madurai-62501

Uses of organo-tin compounds

THE industrial usefulness of the 1 organo-derivatives of the group IV elements, such as tetramethyl and tetraethyl lead additives for petrol and the silicone polymers is wellknown. However, during the last decade the organic derivatives of tin have attracted a considerable interest. This has been mainly because of the versatility of organo-tin compounds in their applications, and the intrinsically low toxicity of the organo-tin compounds as compared to their organo lead and organomercury counterparts. Mentioned below are some of the fields in which organo-tin compounds have been put to use.

Preservation of wood

The most effective organo-tin compound to be used for this purpose is bis (tri-n-butyl tin) oxide, (Bu Sn), O, commonly known as TTO. This compound has also been thought to be a simple toxican against wood-boring insects such as furniture beetle. Although most of the tributyl-tin based wood preservatives are applied in organical solvents, there has been much interest in developing aqueous for mulations so as to reduce the application costs.

Anti-fouling paints

Another field in which tri-organo

s, such as tributyl and triphenyl tin impounds, have found applications the manufacture of marine antiling paints. The tri-organo-tin impounds are gradually released om the paint into the sea water here they act as toxicant to the arine growths and protect the timer-hulled boats from marine boring eatures.

Tributyl and triphenyl tin comunds have also been used for the pregnation of celluloseand woollen brics to provide resistance against ngal attack and destruction by oths.

ganotius in agriculture

Triphenyltin hydroxide and trienyltin acetate are being increasly used in agriculture for controlling variety of fungal growths especially tato blight. Some triphenyltin impounds are also being used as emosterilants.

Tricyclohexyltin hydroxide is a very fective acaricide for controlling uit tree red spider mite on apples ad pears.

In the field of insect control, the ialkyltin compounds, particularly a trimethyltins, have been found to very effective. But their practical ility is restricted by their toxicity mammals and plants

VC stabilisers

Organo-tins are relatively expenve PVC stabilisers and are used hen colourless materials with a high egree of transparency are required. ecently two such compounds amely, di-n-octyltin cis-butene loate polymer, and di-n-octyltin-S, - bis (iso-octyl mercaptoethanoate) ave found useful in PVC packaging f foodstuffs.

Dimethyltin- S, S'- bis (iso-octyl ercaptoethanoate) has recently been sed as a heat stabiliser for PVC rinkable water piping. Some mono-lkyltin compounds such as n-butyl-

tin sesquisulphide are also finding use as stabilisers but are limited to certain grades of PVC.

Other applications

Dimethyltin dichloride instead of stannic chloride has recently been used in Japan for coating glass with a thin film of stannic oxide. The process consists in bringing the vapour of the organotin compound in contact with the surface of the glass at temperatres above 450 °C, where decomposition and oxidation

occur. The glass surface is thu rendered scratch-resistant, lustrou and electroconductive, depending upon the thickness of the stannioxide film.

found use in hospitals in disinfectant sprays, waxes and polishes to reduce staphylococcal and other infections. Some of the organotins are reported to be useful in cancer treatment.

Tributyltin compounds have also

R.C. KAPOOI Chemistry Deptt., Christ Church College, Kanpu

Fruit and flavoured yoghurts

FROM times unknown, people in various parts of the world have fermented milk to obtain palatable products. These products are particularly popular among children and aged people who often do not like to drink milk. Dahi is one of such products consumed in almost all homes in India. The taste and flavour of dahi are not uniform and are known to vary widely from one part of the country to another or even from one home to another.

The modern era of fermented milks began with the observation of Metchnikov, E. (1908) that consumption of fermented milk popularly known as "Bulgarian milk" contributed to the longevity of the Bulgarian people. The sure of longevity attracted the European countries which in turn led to the development and commercial production of yoghurt and allied products. Today therapeutic, curative and nutritional properties of dahi are widely accepted.

Manufacture of yoghurt

In the commecial process, yoghurt is produced by the fermentation of milk by two thermophilic (high temperature tolerating (ranging from 35°C-55°C) organisms viz. Strepto coccus thermophilus and Lactobacillu They grow in a har monius condition known as sym boisis. The final product is highl slightly sour with it viscous, characterstic "Yoghurt" flavour an The manufacturing detail of the production of yoghurt hav been described in some publica tions, although slight variation in details may exist from factor to factory.

The essential features of all the methods of production of yoghur are:

- Selection of milk.
- Standardisation (fat extra ted)—milk powder of conce trated milk added.
- Warming and homogenisatio
- 4. Heat treatment (steaming finalf an hour)
- Cooling to about 50°C.
- Inoculation with yoghurt cutures.
- 7. Packaging.
- Incubation in warm roo (42°C-44°C).

- 9. Cooling in the air.
- 0. Cold storage.

lternate steps:

Incubation Cooling Agitation Packaging

The variations in commercial pracces in the manufacture are related two aspects only; (1) standardisaon of milk in respect of fat and olids-not-fat (SNF) and (2) the stage f packaging the product. Yoghurt ontains 2% to 3% fat, but even a at-free product is acceptable to nany. Usually, the SNF content raised to 14%-16% to make it a nore viscous product and to increase s protein content. In regard to ne second aspect, the modification volves marketing the yoghurt as highly viscous uniform product tirred curd' instead of the normal irm-set or junket form'. As shown bove as an alternate step of manuacture, the milk after inoculation is eld in the vat at 42°C-44°C until it oagulates, then it is cooled by circuting chilled water with gentle agitaon and packaged in suitable coniners. The filled containers are hen cold stored (at about 5°C-6°C) nd held overnight to develop the haracteristic yoghurt flavour.

the acidity is about 0.9% but can o upto 1.1% (pH 4.0-4.2). Higher cidities may be tolerated if milk ortified with extra milk solids is used. Although this high protein food will be quite suitable for salad dressing which is the practice in the U.S.A. and other countries) or for eating with ice (which is the practice in most south Indian homes), the product may be too sour for direct consump-

The product so obtained will be

lightly sour but with a clean flavour.

ruit and flavoured yoghurts

A recent innovation which has

enhanced the popularity of yoghurt is the practice of fortifying it with sweetening agents, fruits and fruit flavours. Fruit and flavoured yoghurts are sweet with the characteristic flavour of the fruits or the added flavours. They retain all the nutritional and curative properties of yoghurt. They are readily accepted by children, adolescents and aged people.

Sweetening agent

Common sugar is the most common form of sweetening agent added. Some people add honey which also increases the nutritive value of the product. The sugar level depends upon consumer preference and is in the range of 6%-8% as sucrose.

Fruits and flavours

Fruits and flavours can be added into yoghurt in a variety of forms. Some add synthetic flavours not to the liking of many. Quite a common practice is the addition of fruit extracts or concentrates. Fruit powders are also added in some western countries. However, the most popular form is the addition of cut fruits or fruit pulps which retain the fresh flavour of the fruit. The types of fruits added are many and variable. The popular fruits are the berries, citrus and apples. Usually fruits are added at the rate of 15%-20% of the product. Fruits and sugar may be added separately or as "fruits in syrup" preparations.

Production of fruit yoghurt at NDRI

The procedures for the production of sweetened and flavoured fruit yoghurt acceptable to the Indian consumer have been standardized at National Dairy Research Institute, Karnal. The product contains 6%-7% sucrose and 15%-20% cut fruits or fruit pulp. Skimed milk is adequate but standardized milk may

also be used. An additional 3%milk powder could be added to crease its protein content and fo value. The skim milk powder co be added to warm milk for dissoluti in the form of thick paste. A prod with a good body can be prepar from skimmed or partially skimm buffalo milk without adding ex milk powder. The general proceds for manufacture is the same as the preparation of yoghurt. Af standardisation, the heat treatme cooling and inoculation of milk w starter culture, the fruit syrup (pr prepared is sugar syrup) is added the rate of 15%-20% of milk. Af thorough mixing the inoculated m is filled in suitable containers, inc bated for 3-4 hrs at 42°C-44°C a then cooled and stored overnight a cold store (5°C-8°C) before d patch for sale. A sugar content 6% and a fruit concentration of 15 20% has been found acceptal to most consumers. Of the various fruits tried the order of preferen was-oranges, apples, mixed frui raisin and bananas.

Preparation of fruit syrup

Fresh wholesome fruits are clean and rinsed with chlorine solution. After skinning, wherever necessar they are made into a pulp with the help of a pulping machine or clean knives and are added to a hot solution of sugar syrup.

The required quantity of free (cut according to the nature of fruits added to 50% sugar syrup and to mixture heated at 85°C for 10 minute. This heat-treatment will destroy the yeast and mold which are always present on fresh frozen fruits. After the heat treatment the product cooled and used immediately, or much be stored in a cold place and warm to the temperature of milk before addition.

As an alternate procedure, t required quantity of sugar can

ion.

dded to the milk before heating and ruit pulp alone can be added after ddition of the starter. However, bsolute sanitary care in selection and andling of fruits will be necessary avoid contamination of the roduct through the fruits.

One of the common complaints bout the product is that the fruits ettle at the bottom of the container. This can be prevented considerably y regulating the size of the fruit pulp. he larger the size the greater is the isk of fruits settling down in the ottom. One procedure followed to void this problem is to add sugar yrup and fruits 1 to 1} hr. after ddition of the starter to milk o that milk becomes somewhat iscous and the risk of settling is educed. It is then mixed and filled n containers, but this procedure ould be employed only when small quantities are handled. If filling annot be finished within half hour he product may show the defect of 'wheying off", i.e., formation of whey it the surface of the product due to listurbance during incubation period.

A sure method to avoid settling of the fruits is to allow milk sugar added to the milk before heat reatment) to coagulate in the vat, and the curd so obtained is stirred with cooling and gentle agitation (as suggested in the alternate method for stirred curd). The fruit pulp is then added, mixed and filled in the containers. The containers are cooled and stored at 0°C to 5°C over-night before distribution.

Storage life

Fruit yoghurts can be preserved upto a week in a refrigerator and for onger periods at temperatures below 5°C. Deep freezing of the product is not desirable as it can cause "wheying off" when taken out for thawing.

Sources of yoghurt culture collection In India, there are only a few

culture collection units which supply different industrial microorganisms to the commercial organizations for the preparation of food products. The main supplier of dairy cultures to the various commercial organizations, particularly for the production of yoghurt and dahi, is National Culture Collection, Dairy Bacteriology Division, National Dairy Research Institute, Karnal. These starter cultures are available in the form of freeze dried vials or liquid concentrates. National Collection of Industrial Microorganisms (NCIM) is another unit in Poona which also supplies yoghurt culture. These cultures can be preserved and maintained pure by using standmicrobiological ardized techniques. Contamination of yoghurt culture with other undesirable microorganisms may lead to changes in the typical yoghurt flavour and acidity, consistency, body and texture of the final product.

Nutritional value of yoghurt

In dietary respects, sour milk products such as yoghurt, dahi, acidophilus milk, kumiss, etc., are far more valuable than milk. During fermentation of milk the composition of the minerals remains unchanged, while proteins, carbohydrates, vitamins, and to some extent fat constituents, are subjected to changes which produce special physiological effects. Dietary and therapeutic qualities of sour milk products are determined by microorganism and substances formed as a result of biochemical process accompanying milk souring. These substances are lactic acid, alcohol, carbon dioxide, antibiotics and vitamins.

The following processes make yoghurt more nutritive than milk:

Proteolysis in milk. Proteolysis in milk takes place by exo or endo peptidase of lactic acid bacteria. The biological value of protein increases significantly during yoghu manufacture from a value of 85.45 to 90%. This increase is due to breakdown of protein into peptone peptides and amino acids. The contents of essential amino acids such as leucine, isoleucine, methioning phenylalanine, tyrosine, threoning tryptophane and valine increas considerably which offer special advantages not only to health people but also particularly to the physically weak.

Hydrolysis of lactose. Lacto in milk is hydrolysed by metabol activity of bacteria., Approx. 2.5 lactose, 0.8 %-1.3% galactose ar 0.03% glucose are obtained fro lactose hydrolysis. Lactose hydro ysis takes place due to β-galactos dase production by lactic acid ba teria. The importance of lactose due to the lactic acid produced fro the hydrolyis of lactose which lead to a pH range in the bowel inh biting the growth of putrefactants. addition to this, lactic acid is impo tant for organoleptic properties ar calcium absorption.

Lipolysis. The homogenization process reduces the size of fat globul which become digestible. The production of free fatty acids as consequence of lipolytic activities increases as compared to mit This leads to some physiologic effects.

Changes in vitamins. There is more than two fold increase in vitamins of B-group especially thiaming (B₁), riboflavin (B₂) and nicoting amide as a result of biosynthes process during milk fermentation Subsequently, vitamin B₂, ascorbacid and vitamin B₃ decrease approximately one half only, as the are utilized by the bacteria in milk Antibacterial activities. The bacterial properties of sour magnificant products are determined by an biotic activity of bacteria growing the product. The antibiotic properties

s are generally associated with ctobacilli in yoghurt and materials sponsible for such antibacterial tion are described as lactic acid, drogen peroxide and other subsnces such as lactobacilline, etc.

herapeutic importance

Sour milk products are well-known r "long life" and "cure all" proerties due to their nutritional, erapeutic and prophylactic values. he main advantages of regular intake fermented milk products such as ghurt and dahi are:

(1) These products are easily abrbed and better assimilated than veet whole milk. Assimilation of milk 32% in one hour, while that of rmented milk products is 91 % in the me period. Better assimilation of rmented milk product is due to paral peptonization and intensity of cretion of ferment by digestive act glands.

(2) They stimulate appetite due their pleasant, refreshing and ingent taste.

- (3) Curd consists of a sufficient nount of indispensable amino acid, ethionine, which removes excessive t from the liver. In case of arterioserosis, methionine improves the neral condition of the patient. ged people should take curd.
- (4) Gastric juice secreted by the tion of fermented milk product nd the desirable ratio of calcium nd phosphorus induced by it leads a high digestive of capability.
- (5) Fat-free curd is necessary or those who suffer from heart sease. arteriosclerosis. hypernsion and chronic inflammation the liver.
- (6) Research workers at Nebraa University in the USA recently ported that consumption of ghurt has definite inhibitory action gainst certain types of cancer cells. No ailment has been reported by gular consumption of the fer-

mented milks. Pathogenic bacteria are not able to survive in fermented milk because of its low pH and other adverse factors for their growth. Intake of higher quantities of yoghurt, of course, may involve the risk of acidosis and may cause adverse effect in adult human. Consumption of less than I litre of yoghurt per day will not affect human health adversely.

The nutritional and therapeutic effects of yoghurt do not depend so much on the living bacteria in the final product as on their metabolites.

D.N. GANDH MEENA SACHDEVA V.K.N. NAMBUDRIPAD Dairy Bacteriology Divn., N.D.R.I Karna

Sulphur for plants

CULPHUR is one of the essential plant nutrients and in importance is perhaps next to nitrogen, phosphorus and potassium. Besides this, sulphur is also a valuable fungicide.

Sulphur is a constituent of many proteins and enzymes in plants and is required for the synthesis of three amino acids (methionine, cystine and cysteine) and glutathione, a compound which plays an important role in respiration. Even enzymatic reactions in plants take place due to the presence of sulphydryl group (-SH). In some cases, these enzymes have been found to increase cold resistance in plants. Sulphur is also a constituent of coenzymes, such as coenzyme A, thiamine pyrophosphate and biotin. These enzymes participate in many reactions involving metabolism of carbohydrates, fats and proteins. Sulphur is essential for the formation of disulphide linkages (-S-S-) associated with structural characteristics of the protoplasm.

Deficiency of sulphur results in chlorosis of the plant foliage, though it is not a constituent of chlorophyll. In sulphur deficiency, symptoms first appear on newly developed younger leaves which give pale yellow appearance. Afterwards the whole plant gets chlorotic and show stunted growth. Plants look thin stemmed and spindly. Deficiency reduces protein synthesis and hence affects nitrogen metabolism. Oi content of oilseed crops and nodula tion of legume roots are reduced due to sulphur deficiency. Maturity of seeds and fruits is also delayed

Sulphur requirements of crops

Sulphur requirement of a crop can be defined as the minimum uptake element associated with of this maximum yield. Sulphur requirement varies with species and even varieties due to their differential genetic behaviour. It also depends upon the intensity and sequence of crops, available nutrients status and incidental additions of sulphur from rains, irrigation, water, atmospheric pollution, insecticidal sprays, etc. Cruciferous and liliaceous plants (cabbage, turnip, onion, garlic) have the highest sulphur requirements (80 kg/ha), whereas cereals (wheat, paddy, barley, etc.) require only 20 kg/ha. Legumes are intermediate in their sulphur requirements (40 kg/hs). Higher needs of sulphur in crucitheir higher contents of sulphur ntaining amino acids and essential and characteristics smell and ste.

hy sulphur deficiency?

It is only in recent years that ficiencies of sulphur have become ore common. Intensive cropping stem and increased yields of crops ive caused sulphur deficiency in ils. Deficiency is also caused by e increasing use of chemically are fertilizers (urea, diammonium hosphate, etc.) which have little no sulphur. Previously superhosphate (11.5% S) used as a ource of phosphorus, ammonium Ilphate (23.9% S) as a source of trogen, and sulphate of potash 7.7% S) as a source of potassium applied sulphur. Even sulphur ontaining fungicides (Bordeaux ixture, lime sulphur) and pesticides, ommonly used until a few years ago, ave been replaced by organic naterials free of sulphur. Decreased se of farmyard manure and compost as further added to the deficiency f sulphur in soils.

In light textured soils of Punjab, laryana, Madhya Pradesh, Uttar radesh, Rajasthan, Himachal Praesh and other states of India, sulhur deficiency has started appearing in a large scale. Its deficiency has lready caused a problem to ground-ut cultivation in Punjab. Deficiency has also been reported for other rops like oilseeds, legumes, maize and wheat.

Taking up deficiency of sulphur

Sulphur can be supplied to plants from a number of sources. It can be supplied through foliage as spray of its soluble salts. Sulphur can also be absorbed as sulphur dioxide through leaves in controlled atmospheric conditions. The efficiency of applied sulphur sources in the soil

depends upon its solubility, particle size and nature of the material.

Gypsum is a naturally occurring source and is found in abundance as deposits in India. There are other sources like ammonium sulphate, sodium sulphate, potassium sulphate, and elemental sulphur. Important factors that determine the choice of the material are its availability and cost.

Deficiency of sulphur has attracted

the attention of scientists. Research on sulphur nutrition of the crop is being conducted at most of the research centres in India and abroad but there is a need for a planned programme on sulphur fertilize in the country for obtaining higher yields.

N.S. DHILLO S.S. BHINDE

Punjab Agricultural Universi Ludhian

Mimicry in large animals

MIMICRY is an evolutionary convergence or parallelism by means of which one species of animal protects itself from predators by imitating the appearance of another.

By mimicking a dangerous or unpalatable animal, an otherwise harmless and edible animal can obtain some amount of protection from predators. A few bitter experiences will be sufficient for predators to avoid the distasteful species. If any other innocuous species closely resemble the unpalatable one, they too are avoided by predators.

The phenomenon of mimicry was first described by H.W. Bates in Brazilian butterflies. Since then, most of the research work is limited to insects, which frequently exhibit mimicry. Although vertebrates rarely display mimetic behaviour, certain birds, snakes and fish do adopt mimetic forms.

In mammals, only two cases of mimicry have been documented so far. The first case relates to a series of five Borneo squirrel species which are the mimics of unpalatable treeshrews. The second and the present case is concerned with aardwolf, a large African mammal, which is found to mimic the striped hyaena

(Nature, Jan., 1975). Mimetic b haviour in a large mammal quite rare, and is the first of its kir reported in literature.

African hyaenas generally inhabithe southern and northern parts of Africa. They are of three varieties the striped hyaena (H. Hyaena brown hyaena (H. Brunnea), and the spotted hyaena (H. Crocuta).

Chiefly nocturnal hyaenas hu singly or in pairs and live in ope dry plains and thorn scrub. The have pointed ears and a sloping barwith an erectile mane. Exce H. Crocuta, others weigh around 50-60 kg. Hyaenas possess a stronget of teeth and jaws and a capable of killing live game. Some times they do kill their prey, but the generally prefer scavenging.

Aardwolf (Proteles cristatus) is smaller mammal than hyaena, weiging about 12-15 kg. With a strip body, sloping back, pointed ea and an erectile mane, Proteles loo remarkably similar to Hyaena. To mane runs along the entire length dorsal spine and is composed of strip lengthy hair. Whenever the mais erected, aardwolf appears to larger than its actual size. It is nocturnal mammal, moving sing

in pairs and inhabiting open lains and thorn scrub. Having only estigial cheek teeth, the animal ainly feeds on insects.

Thus the outward appearance of ardwolf in body, mane, tail and ripe colour is the same as that striped hyaena. General behaour of the two animals is likewise milar. Both are nocturnal, going tout singly or in pairs, and living in the same area. Even their defensive sponse of kneeling, when attacked, identical.

Difference in size appears to be e only external dissimilarity between e two animals. As size is a ry vague indicator, it is difficult differentiate them even at close oximity.

Studies conducted on internal ructures of aardwolf and hyaena other emphasise their close relationing. The chromosomes, haemobin mobility, and the dental forula of Proteles are similar to those Hyaena and Crocuta. Gyri and lei of the cerebral hemispheres are so found to be of identical ttern. The male reproductive act of Proteles is more like that of yaena than that of Crocuta.

Dentition is the major difference in e internal anatomy. Aardwolf has ry small teeth, and retains the llex—a digit lost in both Hyaena d Crocuta.

Precise phylogenetic relationships nong these animals are not yet ablished. But fossil records point t that Hyaena and Crocuta might we diverged since the Miocene. oteles, on the other hand, seems have separated from the hyaenid ock during the Pliocene or at an elier time. Hyaenid relationships all be explained on the basis of the ohypotheses.

Proteles might have diverged from common ancestor of Hyaena and ocuta, before they themselves parated. Loss of pollex in both

Hyaena and Crocuta indicates such a possibility. In such a case, the external similarity of aardwolf and stripped hyaena is an example of evolutionary convergence.

On the other hand, Crocuta might have deviated from the Proteles-Hyaena stock before their separation. This possibility exists because of the similar body shape and the identical male reproductive tract in the latter two genera. If so, the external similarity between Proteles and Hyaena is due to a parallel retention from a common ancestor who had the same appearance.

Specialisation in closely related animals implies a significant divergence in geographic distribution, in outward appearance, or in behaviour. Hence, it is unusual for the closely related Hyaena and Proteles to have a similar habitat, body shape and behaviour. Aardwolf fulfils all conditions of the mimicry phenomenon, and this alone explains the underlying cause of its distribution, appearance and behaviour.

Now the question is, will the

mimicry be of any value? Leopard distributed throughout the range Proteles, are a visually oriented production. They are most active night and generally prey upokackels. Considering their wide prey tolerance, leopards might also feed on aardwolfs. Hyaenas would be dangerous to an attacking leopard because of their large size and strong skull. On the other hand aardwolf, being smaller and weaked than a hyaena, would be a poomatch for the leopard.

Therefore, an important aspect of aardwolf's defence against leopard is likely to be its external resemblance to hyaena. The predator face much difficulty in recognisin aardwolf, especially when it look larger by erecting the mane. Eve the imitation of hyaena's defensive kneeling posture helps aardwolf is confusing predators. Thus, mimicrappears to be quite valuable for aardwolfs to gain some measure of protection from potential predators.

S.K. TATINEN

Stickleback fish : sexual responses and behaviour

THE study of animal behaviour began with early man's first systematic attempts to draw conclusions and make predictions from his observations of the creatures around him. Yet, today, it remains one of the most complex and challenging branches of all sciences. The actions of all animals are directed towards themselves keeping alive reproduce. The assertion that an organism maintains a relation with its environment implies that organism changes its response to

changes in the environment. These changes can be called as behaviour.

Behaviour may be defined as the externally apparent activity of a whole organism. Its essential characteristic is movement, which is found in most animals and some plants, and it is the result of external and internal changes called stimuli.

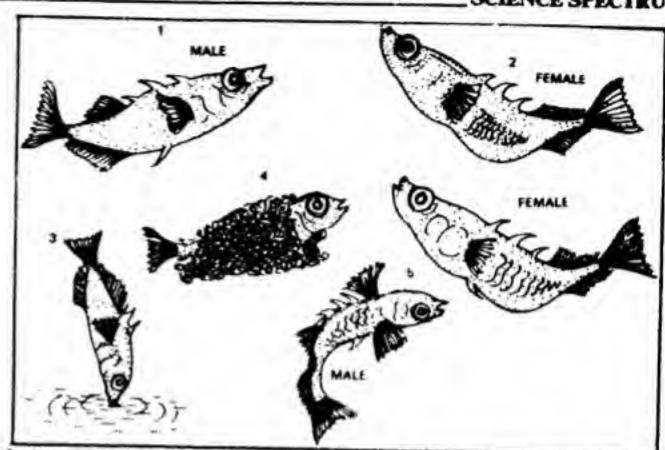
Behaviour may be classified in many ways, each independent of the rest. It may be organized into complex patterns either by the biological process of heredity or by the

psychological process of learning or both. The extreme cases are called innate (or instinctive) behaviour and learned (or conditioned) behaviour, respectively; but most of the behaviour is affected by both types of organization. Behaviour is closely related to function. There are four primitive kinds of behaviour having obvious adaptive results: ingestive behaviour which includes eating and drinking; shelter seeking; sexual behaviour; and investigatory or exploratory behaviour. Behaviour is called normal or abnormal according to the degree of adaptation produced. Behaviour may also be classified according to the kind of stimulus which elicits it, in which case the behaviour may be called a tropism or taxis. The sexual responses and sexual behaviour among stickleback fish are described below.

These fishes are three spined and are remarkable in many ways. Analysis of its activity during its reproductive cycle has revealed the importance of simple stimuli—the so-called sign stimuli—in touching off reactions in both sexes.

First of all, the male and female must be ready for reproduction. This happens in spring when the gradual lengthening of daylight activates glands secreting reproductive hormones. It causes the sticklebacks to migrate from wintering grounds in deep fresh water or the coastal sea to shallow, fresh water spawning grounds. Here, affected by the change in temperature, and motivated by the availability of nesting places, the male changes its original colour. its original colour is creamish grey with dark stripes on sides. The colour of the belly starts changing to red. Its red belly is one of the first of several "signs" that direct the behaviour of males and females throughout the reproductive cycle.

The male stickleback with its winter colouration swims away from a school of males and females to search



A male three spined stickleback.
 A female three spined stickleback.
 A male stickleback clearing a shallow pit and building a nest.
 Zigzag courtship dance of male in front of a female

out a territory in the shallow water. It assumes its pre-nuptial colour and becomes increasingly aggressive, prepared to defend its territory against all other male sticklebacks and, at this stage, even against females. The male then assumes a posture of threat. This brings its red belly into view, a sign stimulus that intimidates other sticklebacks. With its domain secure, the male sets about building a nest. First, it clears a shallow pit and collects materials to build a nest which consists of strands of algae and weed bits. After depositing the strands of algae and bits of weeds over the pit, the male swims to and from over the loose pile. Secreting a sticky kidney fluid, the male glues the nest together. Then the male again undergoes another colour change: the belly which was red becomes bright red and the back becomes bluish-white. This acts as an attracting stimulus for its prospective mate. Now the male is ready to court a female.

Stimulated in turn by the female's egg-plump form, the male goes into a zigzag courtship dance, during which it may brush the female's belly with its stickles. The female responds

to the semale's head-up sign of acceptance, the male shows the semale the way to the nest. The male indicates the entrance to semale by turning on its side and pointing inside with its snout. Once its mate has entered, the male hovers overhead, prodding the base of the semale's tail with its snout which induces spawning. When the eggs are laid by the semale inside the nest, the male enters the nest and sertilizes the egg clutch. As is apparent the fertilization is external in this case.

After mating with several different females – usually two or three—the male begins to fan water over the eggs to aerate them. The male takes care of the eggs. When the brood hatches after a week or so, the male wearing its protective colouration guards the young ones. If the young ones roam too far, the male picks up the strays in its mouth and spits them back into the nest. The male looks after the young ones, until they become independent.

P.P. GEETHA

Commonwealth Instr. of Biological Control, Bellary Road, Bangalore-560006

Personality determines diseases

THE personality of a man is the sum total of his physique, physiogy and psychology. It is a partialar type of constitution which is pecific to an individual. In reent years it has been found that ersonality of a man also determines e types of diseases likely to afflict im. Due to clinical importance of e personality and disease relationnip, it has been felt by researchers to evice a single criterion to classify e total personality of a man. .H. Sheldon in 1940 classified an physically into three types: tomorphs, mesomorphs and endoorphs, based on the criterion of hysical outlook. He further classed man temperamentally into cererotonia, somatotonia and viscerotonia. However, he failed to velop a single composite criterion r classifying total personality based the recent concept that the mind nd the body are not two different tities but are interdependent. A imposite criterion is therefore nessary. The intergrated approach the body and the mind gives rise the concept of psychosomatic institution or personality. Accorng to this concept the mind and the ody are interdependent on each ther and they are the two comonents of the one composite itity, the personality or psychosoatic constitution. The interdeindence of the two components of e personality is evident from the ychosomatic disorders such as ptic ulcers, thyrotoxicosis, hypernsion, coronary thrombosis, etc., hich are closely related to disrbed emotions.

In view of this viewpoint, it is sirable to develop a single criterion

to classify the total personality to correlate one's constitution with his disorders. It is well known that the central nervous system controls all the physical processes and functions through its neurohumors (neurotransmitters) namely acetylcholine, catecholamines and histamine, which along with the related enzymes form a link between the mind and the body. Any kind of physical or psychological stress is known to cause at first an accelerated neurohumoral response. These neurohumors in turn produce a chain response leading to secondary bodily effects; the first neurohumor to be liberated is probably acetylcholine which is followed by catecholamines and histamine respectively. It appears that there is some inter-related mechanism responsible for this sequence of chain response; the composite neurohumoral response in each individual is a basic phenomenon. Since each individual, except identical twins, has a different genetic make up: it is possible that each individual may have a relative preponderance of one or the other of the three neurohumors and the related enzymes. The measure of the relative preponderance of neurohumors or the related enzymes therefore may be used as a criterion for classification of individuals or psychosomatic typing. In view of this, professor K.N. Udupa and his collegues at the Institute of Medical Science, Banaras Hindu University, Varanasi carried out their studies (Indian J. Med. Res., 63:7, 923-27, 1975) on apparently healthy adult men.

The subjects, eighty four in number, were classified on their physical hasis into predominantly ecto, meso

and endomorphs, which impli preponderance of linearity, musc larity and obesity respectively. T plasma level of the enzymes his minase or diamine oxidase (DAC monoamine oxidase (MAO) a red blood corpuscles cholinesters (ChE), responsible for the metab lism of histamine, catecholamine as acetylcholine neurohumors respe tively, were determined. These enz mes are known to have parallelis with their respective neurohumor The results of the above studies, e cept Ch E which did not vary sign ficantly in basal conditions, a shown in the Table below, T choline-sterase was, however, four in preponderance in ectomorp under stress conditions.

Predomi- nantly Ectomorphs		Predomi- nantly Mesomorphs	Predomi nantly Endomorp	
DAO P.U./ml	121.36	115.13	155.14	
MAO P.U./ml	14,65	20.83	14.61	

As is evident from the blood leve of these enzymes, the experimen of Udupa and collegues exhibit relative preponderance of acetylche line, catecholamines and hista mine in persons of ectomorphi endomorph mesomorphic and somatotypes respectively. Th above findings were used by Udup et al., to classify the three somato types into histomorphic, vasotroph and neurotrophic respectively, i view of the specific functions of th respective neurotransmitters. Thes psychosomatic types, classified o the biochemical basis, represent bot the psyche and the body, and ma be helpful in interpreting the inc dence of stress disorders in relatio to one's constitution.

ZAKA IMA

ungro disease of rice—its leaf hopper vector and its control

MONGST food grains in India, rice occupies the foremost place it is grown on about 33 million ctares, i.e., 25.5% of the total wn area with an annual production about 33 million tons. The loss rice crop due to insect pests is timated at 10 per cent. In 1973-74 one, India lost more than Rs. 1500 ores worth of rice due to pest vages

One of the most potential factors limiting the yield of rice crop is the gular appearance of leaf hoppers. nese insects are minute in size, but the loss due to them is immense, they not only drain out the sap from the plant tissues but also transmit that diseases. Tungro is one of them which has threatened rice cultimation in many parts of the world. I recent years, in India also it has become a serious problem of national aportance.

ymptoms of tungro virus

As the name suggests, there is a egenerated growth of the plants. eaves of such affected plants turn ellow, the tips dry up. Yellowing f leaves may first appear as partial r in stripes with diffused chlorotic ottles. Or there may be yellowishwhitish spots on the younger aves. In certain varieties the chloroc leaves turn yellow-orange and equently develop irregular dark rown blotches. The colouration is fore intense on leaf tips than at the ase and more in outer leaves than inner ones. Often leaves show ymptoms of vein clearing also. The isease is more likely to occur in arlier stages of the crop. The ounger the seedlings infected, the reater is the damage. There appears be a definite case of an age induced resistance. In affected plants, flowers tend to blossom late and produce inferior grains of a dark brown colour. The fields, in general, present a wavy appearance owing to differences in height of affected plants.

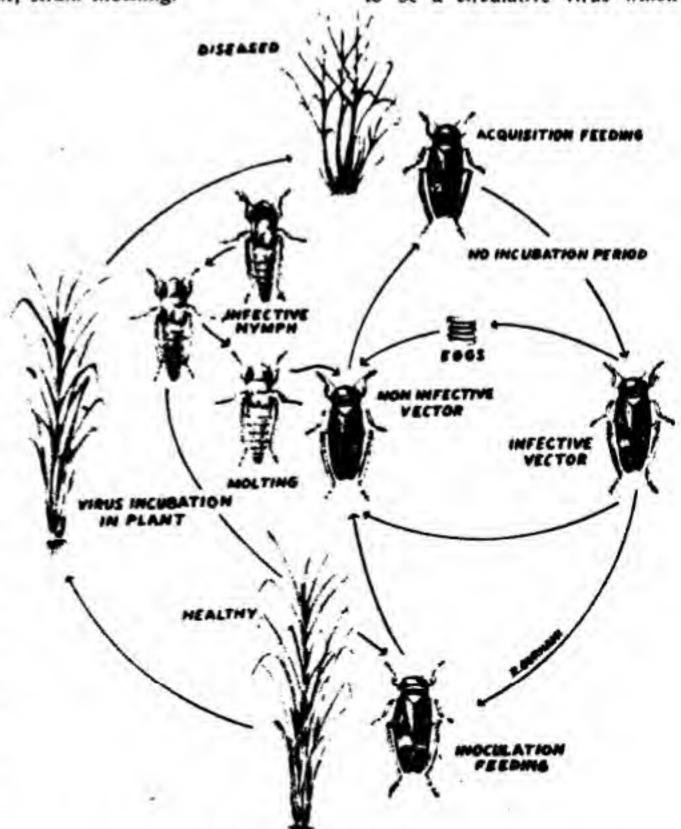
The virus

The disease is caused by rice tungro virus. Two strains of virus, S and M strains, have been identified. They are distinguished by the symptoms produced on differential varieties; the S strain (the more common one) produces leaf striping and the M, strain mottling.

Mode of virus transmission

The tungro virus of rice is trans mitted by a green leaf hopper vector Nephotettix virusens Ishiahra. Near 83 per cent of the population of th vector has been recorded to transm the virus activity. The virus acquired and transmitted by bot the nymphs and adults of this vecto The minimum acquisition feeding of 30 minutes on an affected plant sufficient to allow the transmission of disease. A 24 hour incubation period appears to be necessary for adult insects to transmit the disease an appreciable extent. One les hopper is sufficient to infect a health plant, with a minimum inoculation feeding period of 15 minutes.

The tungro virus has been reporte to be a circulative virus which



Pig. 1. Transmission cycle of tangro virus

quired through the mouth-parts d accumulated internally without parent multiplication. Later, it passed through the insect tissues d introduced into the plants again. In N. virusens, the transmission ne is short and it is not capable of ansmitting the virus following oulting but could become reinfece by renewed feeding on diseased ants. The tungro virus is nonrsistent in the rice green leaf hopper. ne transmission of tungro virus in e in relation to its virus vector is own in Fig. 1.

af hopper vector (Nephotettix runes)

Identification. Adults are 3.2 mm 5.3 mm long, greenish in colour d with black spots on the forewings males. Females are devoid of ch spots (Fig. 1).

Life cycle. The nymphs and adults use direct damage by feeding on p of the young plant leaves and on e base and leaves of mature plants. ges are laid in the leaf sheath where ey hatch in six days. The average imber of egg masses and eggs laid a single female is 27 and 340 spectively. The nymphs have a ried colour pattern in notum and ey undergo five moults to reach e adult stage in 16 to 18 days. The ngevity of adults varies from 27 to days during different months of e year.

The adults appear in the seed-beds d newly transplanted crops during ne to August, and reach a peak iring October to November and cline thereafter. During ason they reach a peak during bruary and March. Thereafter e population dwindles.

Seasonal history. Mostly the adults e carried over to the next crop ter passing a short period on asses and ratoons left after harvestg the crop.

Among the wild hosts recorded,

leaf hoppers were found breeding mainly on sawnai or junglee rice (Echinochloa colonum) and rice-cutgrass (Leersia hexandra).

Rain regulates changes in vector populations. Further, it has been observed that light interrupted with frequent showers favours increase in vector population, while heavy rainfall appears to be detrimental.

Control measures. The most effective method of controlling the disease is selection or breeding of varieties resistant to tungro virus. Some of the varieties reported to be resistant are Pankhari 203, Kamod 253 and Katribbog. These varieties have heen developed and multiplied in Maharashtra whereas Latisail, which has also shown appreciable resistance to this disease, grows in West Bengal. Amongst the varieties from U.P., T. 9 has been reported to be free from the disease. The varieties reported herein can successfully

be grown in most of the rice grow areas of the country. Of cour transmission studies are required confirm whether the variety is rea resistant or not.

In order to check the spread of t disease in fields it is necessary control the population of leaf hopp with insecticides. App granular insecticides like sevid phorate, or diazinon at 15-20 l hectare at the time of transplanting The insecticide should be applied 7.62 cm standing water for 48 hou It should be followed by two spra ings of 0.05% dimecron, 0.03 rogor or 0.07% thiodan E.C. at 7 litres per hectare. These treatmer should be given 40 and 65 days aft transplantation of the crop.

Y.K. MATHI J.P. SRIVASTA Division of Entomolog C.S. Azad University of Agri. & Tec Kanp

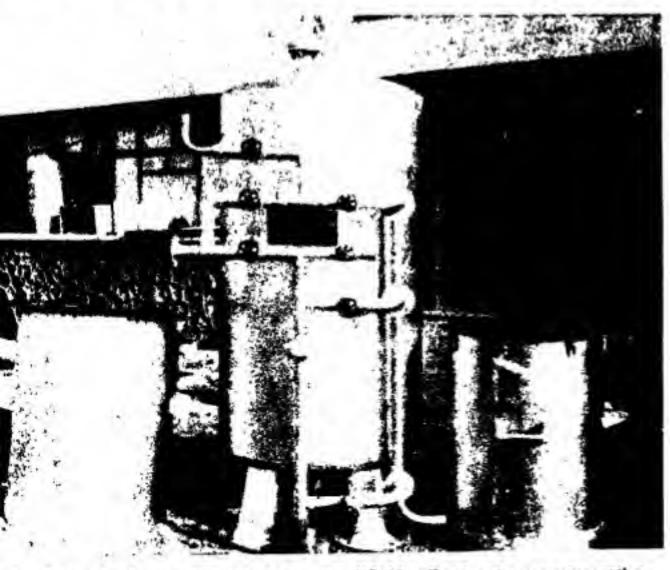
Defluoridation of water by Nalgonda technique

CLUORINE, the most electronegative of all elements, has not only notable chemical qualities but also physiological properties of great interest and importance for human health and well-being. The role of fluoride ion in human or animal metabolism is not known with any certainty. From all the work available, it is clear that a certain quantity of fluoride ion is essential for the formation of caries-resistant dental enamel and for the normal process of mineralisation in hard tissues. About 95% of the fluoride in the body is deposited in hard tissues and it continues to be deposited in calcified structures even after other bone constituents have reache a steady state. Age is an importafactor in the extent to which fluoric is incorporated into the skeleto A similar pattern, as in bone, followed in the fluoride concentra tion in teeth. The uptake almo ceases in dental enamel after the ag of about 30 years.

A condition, now known as denta fluorosis or mottled enamel, wa described by Eager in 1901 amon the emigrants from Italy. The ten mottled enamel was first introduce by Black in 1916 in an article joint! published with McKay in which th disease was described in details. was in 1931 that a direct relation



ig 1. A typical case of dental fluorosis



2. Full scale plant to treat 115 cubic meter (25000 gallons) water per regenerating using Defluoron—2

ship between mottled enamel and fluoride content of water was established.

Prevention of dental fluorosis

Dental fluorosis occurrs in human beings consuming water which contains 1.5 mg F/I or more fluorides particularly during the first eight years of the life. Mottled enamel usually takes the shape of modification of tooth enamel to produce yellow or brown stains or an unnatural opaque chalky white appearance with occasional striations and pitting. The incidence and severity of mottling was found to increase with increasing concentration of fluoride in drinking water.

The Ministry of Health, Government of India, had prescribed 1.0 and 2.0 mg/l as permissive and excessive limits for fluorides in drinking water.

It is known, however, that most natural surface waters, have 0.0-0.5 mg/l of fluoride. Occurrence of excess fluoride bearing waters was reported by many workers from Andhra Pradesh, Rajasthan, Punjab, Haryana, Uttar Pradesh, Madhya Pradesh, Gujarat, Tamil Nadu, Karnataka and Maharashtra. The general level of fluorides is between 1 and 5mg/l except in a few cases, where the concentrations are reported to be as high as 16 mg/l.

The work on defluoridation was taken up by National Environmental Engineering Research Institute in 1960 on a reference from some State Governments having such a problem The Institute has worked since ther on several materials like clays, mine rals, ion-exchange resins, activated carbon, activated alumina, sulphona ted coals and serpentine. Those tha showed an encouraging trend or bench-scale were further examined in details. These include ion-exchang resins, saw dust carbon, coconu shell carbon, defluoron-1, carbior (Continued on page 134

SCIENCE REPORTE



Nobel physicist Dr. Heisenberg passes away

DR. Werner Carl Heisenberg, the world famous nuclear physicist who established the Uncertainty principle as a basic theory, and who received the Physics Nobel Prize in 1932 at the extraordinarily young age of 31, died on February 1 at the age of 74 in Munich, West Germany. An author of many standard books on nuclear physics, Dr. Heisenberg was one of the foremost contributors to the 20th century physics.

Born of an intellectual family on December 5, 1901, in Duisberg, ermany, young Heisenberg was ducated in Munich. At the Uniersity of Munich, he studied theorecal physics under physicist Arnold W. Sommerfeld (1868-1951) and eceived his doctorate degree in 1923. e served for a year as an assistant to hysicist Max Born (1882-1970) at e University of Gottingen and then ent to Copenhagen to study ith physicist Niels Bohr (1885-962). He returned to Germany as a rofessor of Physics at the University Leipzig in 1927. In 1941, he loved to the University of Berlin as rector of the Kaiser Wilhelm Instiite of Physics. After the World ar II he returned to Gottingen and came director of the Max Planck stitute for Physics and Astrohysics. He refined matrix algebra nd matrix mechanics to explain the

wavelengths of spectral lines of atoms. He predicted that the hydrogen molecules could exist in two forms: orthohydrogen in which the nuclei of the two atoms spun in the same direction, and para-hydrogen in which they spun in opposite directions. This prediction was confirmed in 1929 and helped in concentrating liquid hydrogen. Dr. Heisenberg enunciated in 1927 his famous Uncertainty Principle

which states that it is impossible to make an exact and sime taneous determination of both to position and momentum of a body. He was awarded the 19 Nobel Prize for this principle. During World War II he was in chart of Hitler's research on the atom bomb.

R.K. DAT

Prof. S.C. Maheshwari : an interview

The Shanti Swarup Bhatnagar Prize for biological sciences for 1972 has been given to D S.C. Maheshwari, Professor of Botany, Delhi University, jointly with Prof. B.B. Biswa Bose Institute, Calcutta.

Prof. Mabeshwari has made significant contribution in the area of plant and ce physiology, particularly in the physiology and biochemistry of growth and differentiation in plants. His researches have revealed a new group of growth hormones, cytokinins.

Prof. Maheshwari and his group has recently discovered the technique of raising haploid plants by author culture. The development of haploids by anther and pollen culture technique makes possible the establishment of homozygous lines in plants.

It is an idiosyncracy of Indian scientists that they value the research of their compatriots only when it has been acclaimed abroad. Instances are countless, but the one I came across recently is that of Prof. S.C. Maheshwari, 1972 Bhatnagar Award winner.

"For 3-4 years botanists in the country were not ready to believe in the tissue 'culture technique' which I discovered in 1967", Prof. Maheswari said. Today his technique has received recognition abroad; and because of its agricultural applications, it has been given so much attention that within the last few years two international symposia were held on the subject. Prof. Maheshwari applied the technique on datura plants, nowadays researches are underway to apply the technique on other plants, in particular, on crop plants. In short, Prof. Maheshwari's technique (of establishing homozygous lines in plants) would in the

long run enable agriculturists to g the same quality of a crop from sul sequent harvests. "Actually I con ducted experiments on a project for a different purpose, the bye-produof it is this technique", he replie when asked how he hit upon th novel method. In fact, the tech nique evolved as a result of effor made by him and one of his student Mrs. Sipra Guha, then a U.G.C post-doctoral fellow doing research under him. "Actually she shoul have been awarded the Bhatnaga award instead of me!" he remarke modestly.

The idiom 'a chip of the old block very much fits in with Prof. Mahesh wari, careerwise and researchwise His father, the late Prof. Panchana Maheshwari, F.R.S., a renowned botanist, made a deep influence of him. "Even when I was a child ther was no doubt of my becoming scientist. In fact the atmosphere was in was so," he said reminiscing his



Prof. S.C. Maheshwari

acca (now Bangladesh), where his ther was head of botany departent. After partition, when the mily returned home, he joined. Stephen's College, Delhi, to Honours in botany. "Frankly eaking, I was more interested in emistry than in botany," laughingly said, "However, on my father's sistance, I took up botany." This esession with chemistry had not ed in course of time but persisted, and paid him off later.

After graduation in 1952 and postaduation in 1954, both from Delhi niversity, Prof. Maheshwari did n.D. under Prof. B.M. Johri of elhi University. He aching, which, according to him, ovided him with "a broader stlook of the subject than research in provide." Later, he visited and udied at several prestigious foreign niversities. He went abroad as U.S.A. Fulbright scholar, Homi habha Fellow, and as a young ientist on the U.G.C. British ouncil programme. Although he udied at various places, he rememers his stay at California Institute Technology for special reasons: here he was working under Prof.

James Bonner, an eminent plant biochemist. Here, for the first time, he got the opportunity to work in an interdisciplinary field-botany plus chemistry. This encouraged him to work along this line, and whatever he has contributed to date is a result of this combination of the two subjects. His field of interest is, therefore, plant physiology and plant biochemistry. At present, apart from his researches on 'tissue culture' technique, he is working his students on Extraction identification of hormones' and 'Effect of photo-period on plant growth and reproduction."

Today there have been revolutionary developments in biology because of the introduction of physics and chemistry into it. The modern biology, therefore, for understanding

and research, demands of a studen good grounding in these subjects "So the present syllabus needs over hauling to suit the needs of modern biology," Prof. Maheshwari feels and he added, "Our students ar good, but the training imparted to them is defective." Quite point not to overlooked be academicians. our parti cularly, biologists.

Botany appears to be in Mahesh wari's family—because his wife, Nirmala, is also a botanist. She teaches the subject in a Delhi University college. His hobbies? Except one, none listening to classical and western music. "After so much tension of work, music gives me complete relief"—that, I suppose, is his secret of working incessantly.

DILIP M. SALW

International Symposium on Industrial Toxicology

N international Symposium on Industrial Toxicology held at Lucknow during November 4-7, 1975 under the auspices of the Industrial Toxicology Research Centre (ITRC), Lucknow, provided a common forum to scientists from different parts of the world to exchange their experience and views on some aspects of environmental and industrial toxicology. Thirty five delegates Canada, Federal from Republic Germany, France, Democratic Republic, German Iran, Japan, Sri Lanka, United Kingdom, United States of America, Sweden and Yugoslavia. Sixty six delegates from India and twenty observers participated in the symposium.

In his inaugural lecture, Pro H.J. Hapke, Institute of Toxicology Hanover, FDR, outlined the me chanism adopted by nature to contain the harmful effects of lead. Adapta tion to lead is mediated by a proces of adjustment of the content an function of certain proteins in th target cell. These proteins have the ability to hold a widely flexible concentration of lead. Anima which were exposed already to s veral low doses of lead, when cha lenged with a toxic dose of the meta withstood the same, indicating th operation of an adaptation mecha nism.

Prof. E. Ostlund, Research Four dation for Occupational safety an Health, Stockholm, Sweden, der ibed the working of the Occupaonal Health Service of the Buildg and Construction workers of weden, a service facility sponsored intly by the workers and manageent of the Building and Construcon Industry of Sweden. He referd to the trend of larger number of eaths due to cancer occurring among umbers, masons, painters, etc., an in a comparable group of Swesh citizens.

Noise due to vehicular traffic, planes, industrial operation, etc., n be an environmental pollutant description and can produce adverse effect on alth. Prof. Alice Lehmann, stitute of Acoustic Physiology, ris, France, described experiments the mice designed to evaluate the nergistic effects of noise and alcolon behaviour.

The session on epidemiology suryed lead-poisoning in a commuy in the vicinity of a lead
selter in the Mezo valley of
sigoslavia, the tile and pottery
orkers of Iran, mentally retarded
sildren, surveillance of lung diseacaused by asbestos and silica,
mp workers' disease, excretion
ttern of toxicants and their procts in human urine, survey of cccutional health hazards in factories
ing hydrogen sulphide, health

problems among are welders and petrol pump workers.

The session on metals surveyed the effect of lead, zinc and manganese on various tissue enzymes of experimental animals. There is a great need to understand the effect of manganese on the nervous system. Iron deficiency was shown to make animals more susceptible to the toxic effect of manganese. There is thus an interaction among metals. The use of chelating agents and the antitubercular drug, p-amino salicyclic acid, in the treatment of metal toxicity was suggested.

In pursuance of recommendation, the Asian delegates to the Symposium formed an Asian Society of Environmental and Industrial Toxicology with its temporary headquarters at ITRC, Lucknow, with Dr. S.H. Zaidi, Director, ITF Lucknow as its president.

The symposium brought to for critical information on the bioc mical mechanism of cell and tist injury caused by toxic materials. It discussions revealed many glar lacunae in our knowledge concering the disease process caused industrial toxicants, and hence it deficiency of both therapeutic a preventive measures. A number new problems were identified a valuable suggestions made for it proving the currently used experimental techniques.

S.J.A. TIRM R.R. KHA I. T. R. P.B. no. 1 Lucknow-2260

Symposium on applied magnetism

A "Applied Magnetism, Magnetic Materials and Magnetic Devices" is being organised by Magnetics Society of India in the third week of March 1976 at Hyderabad. For more information, write

Dr. M.K. Joshi, Hony. Gener Secretary, Magnetics Society of Indi C/o DMRL, Hyderabad-500258.

OLYMER SCIENCE (Continued from page 149)

gy. Hand in hand the search for w polymers is keeping pace; for en the presently available polymers e not completely free of disadvanges. Recent approaches towards e solution of this problem involve ecific structural modifications of e polymer to eliminate the source of sadvantage. Such an approach has en largely aided by the rapid groth of polymer science as a separate

and rigorous scientific discipline and the continuing demand all around the world for better and useful manmade materials.

Further reading

S.K. De, Science Reporter, 9
 (January 1974); S.K. De, ibid., p.163 (April 1974); S. Maiti, ibid, p.525 (Dec. 1974).

- Pearce, E.M., Ed., Acrylonitrile Macromolecules, Applied Polymer Symposia No. 25, John Wiley and Sons (1974).
- Takamatsu, T. Ohnishi, A.
 Nishikada, T. and Furukawa
 Alternating Butadiene—Acryle
 nitrile Copolymers, Rubber Ag
 Volume 105, p.23 (1973).



Vitamin B₁₇—an anticancer agent?

CCORDING to Ernst Krebs, Jr., Vitamin B₁₇ represents some ozen compounds collectively known nitrilosides or cyanophoric glycosies that are produced in over 1000 secies of plants. Some of them are f dietary significance in animal utrition, metabolism and function. he most commonly available cheical form of such vitameric nitriosides is amygdalin (also known as etrile, nitriloside), a compound rst isolated in 1830 by Robiquet and loutron as a white, crystalline, water oluble, slightly bitter sweet and nonoxic substance, later found to be resent in the seeds of many fruits nd in parts of other edible plants. has been a food to man from his rimitive days and is a notable onstituent of the dies of wild arnivores and herbivores, as well s of the domesticated sheep and attle. Rich sources of amygdan are apricot nuts, cherries and runes. Chemically, D-mandelonitrile—β-D-glucosido--β-glucoside. Many therapeutic ffects of pure and impure preparaions of amygdalin have been repored including their laxative, sedative nd antihelmintic actions. The combound is also known to be useful in he treatment of asthma, acne, impeigo, prurigo senilis and edema.

Recent years have seen a great controversy over the use of vitamin 317 as an anticancer agent. The first known accounts of anticancer activity of amygdalin appeared in 1845-46, when a French physician, J.D. Inosemtzoff treated his patients with , oral amygdalin. A similar report from the United States first appeared some 80 years later. Interest invitamin B,, as an anticancer drug was revived in this country in 1953, when the Cancer Commission of the California Medical Association contended amygdalin to have produced certain metabolic and palliative effects in human cancer patients. Such a notion was endorsed in 1963 by the Cancer Advisory Council of the California Department of Health. With metabolic improvement, a variety of benefits for a normal health and for metabolic and nutritional states in pathological conditions like cancer, sickle cell anemia and asthma, etc., ensue. Currently about 20,000 cancer patients in the United States are taking amygdalin, usually by mouth. But they do so without a physician's prescription; since according to the regulation of the Food and Drug Administration, amygdalin cannot be prescribed as an anticancer drug. However, there is no legal bar on the chemical to be sold as a 'food' in this country. It is also known that amygdalin in the patent name laetrile is being taken by numerous cancer patients throughout the world, essentially without abrogation of the existing law.

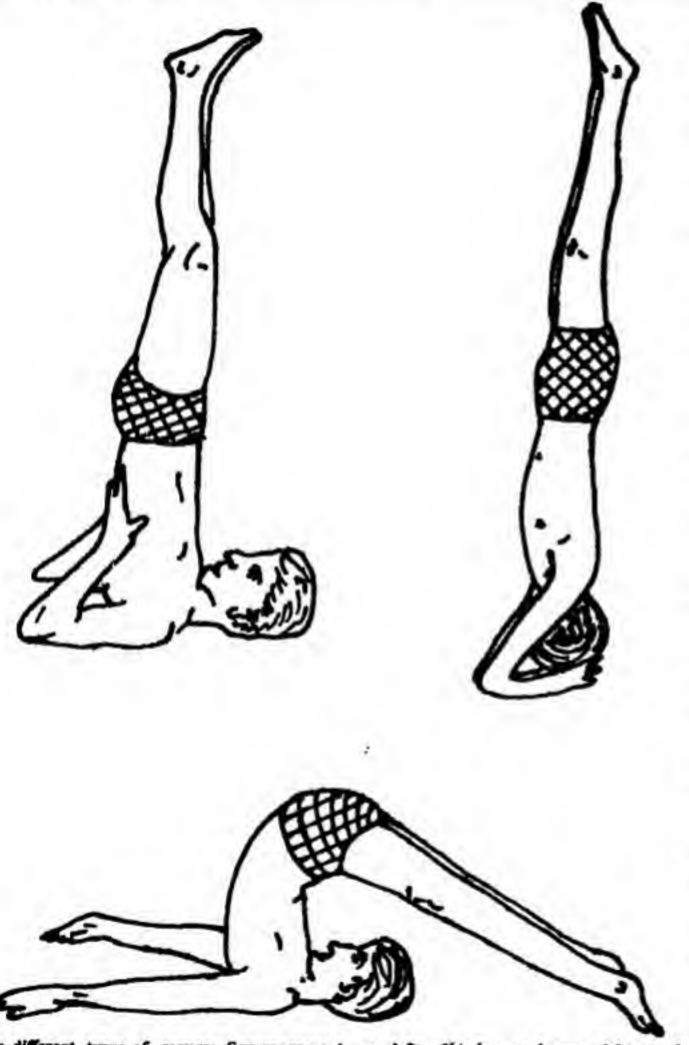
The anticancer activity of laetrile has been confirmed by five independent research institutions in the United States, France and West Germany on a wide variety of animal cancers and human cancers maintained on animal hosts. The chemical is believed by some investigators to control cancer by stopping the rapid multiplication of tumor cells. However, the Food and Drug Administration of the United States, American Cancer Society and the American Medical Association claim laetrile as ineffective in human cancer control. The laetrile advocates counter that the substance has never had a true test by authorities, that it

is suppressed unfairly and unscient fically, and the reason for the suppr ssion is that cancer is a business 16 billion dollars per year for the nation's medical community as drug industry. Dr. Dean Bur Head of the cytochemistry section the National Cancer Institute Bethesda, Md (U.S.A.), recently to a convention of the Cancer Contr Society that he considers lactrile " front right now as a treatment f cancer". Dr. Ernst Krebs, Jr., enthusiastic advocate of laetr therapy of cancer, recently told t National Tattler: "When all is over they will find that laetrile controver is the watergate of cancer research Amygdalin has been found to harmless through various anim and human experiments and its no toxicity as a food item is now beyon question. In all fairness, therefor in any part of the world, legislation should not deprive this so-call anticancer vitamin of a reasonal trial in human subjects.

B. P.

Yoga induces physiological effects

TOGIS have long claimed th yoga can cure diseases. Scep cism however persists. There h also been a debate whether yo induces any physiological effect the body. Professor K.N. Udu and his colleagues at the Institute Medical Sciences, Banaras Hin University, Varanasi, have recen shown that the effect of yoga is n only physical but also biochemic and physiological. They have show by experiments on human subject that combined practice of yoga p duces psychological, neurohumor physiological, endocrine and otl



be different types of asanas: Sarvangasana (upper left), Shirshasana (upper right), an Halasana (lower)

hese studies evidently reveal that he action of yoga in the body is eeper than generally understood.

The optimum practice of yoga onsists of eight successive stages. The different types of asanas (physical postures) are preparatory steps in the total practice of yoga. Because

the practice of individual asanas or physical postures may have its own significance in total or combined practice of yoga, it will be worthwhile testing the effects of practising individual asanas. Such knowledge will be useful in devising therapeutic application of individual asanas in clinical practice or otherwise for

practising them to keep good heal Dr. Udupa and his colleagues his conducted a study on human st jects, which were divided into the groups (Ind. J. Med. Res. 63 1066-71, 1975). Each group prac sed for six months one of the thi important asanas, namely, Sarvany sana (standing on shoulders), Sh shasana (standing on head) a Halasana (plaw pose). Each of the assures was practised along with respective complementary postu i.e., Matsyasana, Mayurasana a Pashchimattansana. These CO plementary asanas are consider to essential optimu obtain results.

The result of each asana showed certain degree of specificity in actio The effects of Sarvangasana were le physical and more physiologicalparticularly induced cardiorespir tory functions. The endocrine other metabolic effects were lo Shirshasna produced less physilogical changes. The effects Halasana were mainly of ph sical nature with minimum physical logical changes. The changes obse ved by the practise of each posture or also be attributed to some extent the accompanying complementar postures.

In another experiment the n searchers found that breathing yog exercise Pranayama not only impro ved respiratory functions but als accelerated adrenocortical function (functions of the cortex region of th adrenal gland). The accelerate adrenocortical functions, according to the researchers, may produce i the subject a competence to cope wit the stress conditions. Each yog practice, despite some broader trends appears to have some degree of specificity of its influence. Obvi ously, such influences may be of us in clinical application of yoga.

ZAKA IMAI

15 1 1 1 1 1 1 1

Separation of protein fractions from blood plasma

TUMAN plasma proteins have I found a variety of clinical applitions. Fibrinogen is used in the eatment of burns and in skin and rve grafting. Fibrin films and ams are used in surgery and orinogen in the treatment of haeophilia. Gammaglobulin is used the prophylaxis and treatment viral diseases like measles and fective hepatitis and for attenuaon and suppression of infective diases in children. Albumin is used r intravenous therapy in conditions illing for massive transfusion of rotein in a restricted fluid bulk. lood albumin from animal sources used as a clarifying agent in wine aking, sugar refining, cooking, dico printing and photography.

The present process has been developed by the scientists of the Indian stitute of Experimental Medicine, alcutta, for the separation of protein actions from blood plasma by recipitation with a mixture of potasum dihydrogen phosphate and didium hydrogen phosphate of proressively increasing concentrations bring the phosphate concentration 1.1, 1.6, 2.0, 2.4 and 3.3 M at H 6.5 to get fractions of fibrinoen, gammaglobulin, beta-globulins, lpha-globulins and albumins resectively.

The separation is carried out at a emperature of 20±1°C.

The non-specific resistance factor, roperdin, is recovered in the gammalobulin fraction.

The process may be applied to lood plasma of either human or nimal origin for the preparation of lasma protein fractions for clinical or commercial application.

The plasma protein fractions from blood plasma prepared by this process have been tested and found to conform to B.P. specifications in fibrinogen and gammaglobulin, and U.S.P. specification in albumin. On disc electrophoresis in ployacrylamide gel, fractions prepared as above have been found to be of comparable purity to those of standard preparations commercially available. Their electrophoretic characteristics on microelectrophoresis in the Antweiler apparatus confirms that their biophysical properties are unaffected by the

fractionation procedure.

The present process offers number of advantages over the con ventional ones based on Cohn method of salt-alcohol fractionatio or the MRC method of fractions tion using solutions saturated wit ether. It can be carried out at 20°C and so costly refrigerating equipmen for maintaining sub-zero temperature is not required. Hence costs would be considerably reduced and th process would be easier to operate The avoidance of organic solven ensures that the biological activity of the separated proteins will not b impaired. The process has bee assigned to the National Research Development Corporation of Ind for release for commercial utiliza tion.

Herpesvirus cancer vaccine developed

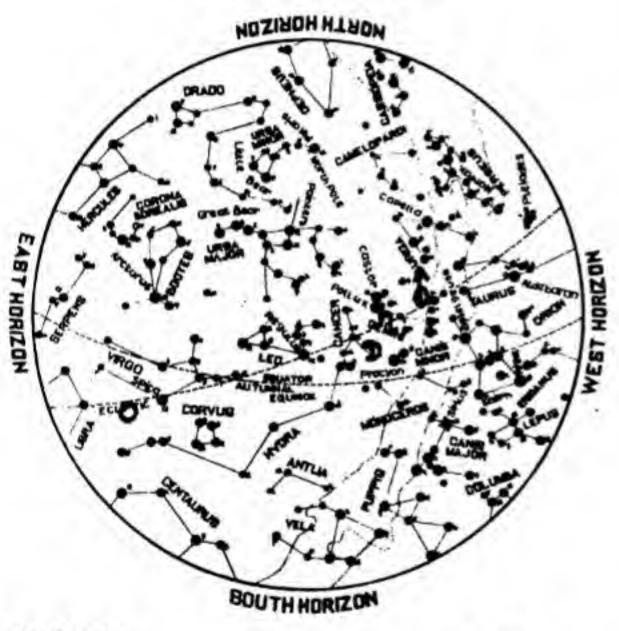
HERPESVIRUS s ateles (HVA) induces malignant lymphoma in several monkey species. The virus has been isolated from a non-human primate (Nature, 352, 182, 1972). Because of its importance to a human herpesvirus, the Epstein-Barr virus, which is associated with Burkitt's lymphoma, is currently the most important candidate as a human cancer virus. HVA-induced malignant lymphoma in marmosets (Sagvinus oedipus) provides a model system for the production and testing of vaccine against suspected oncognenic herpesvirus in man. Drs. R. Laufs and H. Steinke of the Hygiene Institute of the University of Gottingen, West Germany, recently prepared a killed herpesvirus vaccine

by inactivation of the oncogen HVA with heat and formaldehye (J. Natl. Cancer Inst., 55, 649, 1975 The vaccine proved safe in 9 ma mosets during a period of 461 day The vaccinated marmosets develope high titers of serum antibodies again HVA and were resistant to 316 leth doses of cell-free HVA; the nonvacc nated control monkeys died of mali nant lymphoma. The five challe ged monkeys were clinically well as had been under observation for 3 days at the time these investigate reported their findings. This succe has implications for the planning production and testing of vaccin against suspected human tumo viruses.

BHAKTI DAT

Planets and their positions

APRIL 1976



PLANETS MARS SATURN

MAGNITUDES MOON

1 1 2 -3 -4 -5 D FIRST QUARTER 8TH

O FULL MOON 14TH

The moon

Full moon occurs on 14th at 19 p.m. and New moon on 29th 3-50 p.m. I.S.T.

The moon passes about two deges north of Jupiter in the evening 1st, six and a half degrees south Mars on 7th, five and a half grees south of Saturn in the ening of 8th, and about 3 deges north of Venus on 28th. The lunar crescent becomes first visible after the new moon day in the evening of 1st. The moon is at perigee or nearest to the earth on 14th and at apogee or farthest from it on 27th.

Solar eclipse

There will be an annular eclipse of the sun on 29th. The eclipse will be visible in the whole of India before sunset as a partial solar eclipse.

The planets

Mercury (Budha) is too near to sun to be visible during the fit half of the month. It will be superior conjunction on 1st. The after it reappears as an evening stand sets about an hour after suns it passes about two degrees not of Jupiter on 12th. It is at the greatest eastern elongation of about 1 degrees from the sun on 28th It moves from Pisces (Mina) Taurus (Vrisha) through Art (Mesha). Its visual magnitur varies from -1.3 to +0.7.

Venus (Sukra), a morning starises about an hour before sunriduring the first half of the monand half an hour before it during t second half. It moves from Aquirius (Kumbha) to Aries (Meshathrough Pisces (Mina). Its visu magnitude is about -3.3.

Mars (Mangala), visible in the evening sky, sets at about local minight during the first half of the month and about half an hour befort during the second half. It is Gemini (Mithuna). Its visual manitude varies from +1.1 to +1.5.

Jupiter (Brihaspati), visible in the evening sky, sets about an hour after sunset during the first half of the month. Thereafter it is too need the sun to be visible, being in conjunction with the sun on 28th. is in Aries (Mesha). Its visu magnitude is about —1.6.

Saturn (Sani), visible in the evening sky, sets at about local midnig during the first half of the monand about half an hour before during the second half. It will in quadrature with the sun on the loth. It is in Cancer (Karkata Its visual magnitude is about -0.3.

Source: Nautical Almanac Ur of the Meteorological Office, A pore, Calcutta-27.



The vast wealth of oceans

ONG ago, in the dim past, a drop of molten matter placed self in the universe and began an dependent life. It turned on its wn axis and gradually assumed a herical form all the while moving an elliptical orbit around the sun, s parent. That drop was earth. As time passed, it began to cool. lore than 70% of its surface got overed by a liquid—water. Matter ok a peculiar turn in its evolution nd a mysterious process called life arted in these waters. Gradually, fe culminated in a thinking tool alled man—a bipedal mammal. le called the vast expanses of waters, ceans.

Oceans are the life blood of the arth. They regulate earth's climate. They are inexhaustible sources f power. They contain immense nineral resources. They have vast tores of plant and animal life which an be effectively used as food for the growing population on earth. For fully utilizing the resources of the oceans new technologies have to be developed.

It will be interesting to have a seep into the future impacts that hese new technologies will produce in he utilisation of the oceans. Drastic changes are expected in the field f production and harvest of food

from the oceans. About 130,000 million tonnes of organic matter is produced in the oceans annually. But, at present, the oceans supply only 13% of the world's animal-protein intake. It is believed that protein from the oceans can feed about half the world's population. But presently mankind is utilising only 1/2000th of the organic matter produced in the oceans. This is because our present techniques of fishing are not conducive to the rapid expansion of the fishing industry. By employing advanced methods like spacecraft and sonar devices to detect fish schools and by resorting to electric fishing we can increase the fish production many times.

Another method of increasing food production from the sea is the direct harvest of planktons. Planktons are the protein-rich microscopic organisms on which shrimps, fishes and whales feed. By one estimate, a plant would have to process more than 1182 million litres of sea water just to produce a tonne of plankton. But their nutritive value is definitely high. Modern methods of processing food stuffs can make the animal plankton both pleasing to the eye and palate. When we have begun to use animal plankton as food, the food resources of the sea within our reach will have increased by 50-10 per cent.

Culturing and harvesting plankto is also a possibility for the future It is estimated that if one millio hectares of the sea is used for plan kton culture, it will give enough pro tein for all the people in the world Production of phytoplankton-th primary food producers of the ocea -is dependent on the availability nutrients like nitrates, phosphate silicates and trace elements from th bottom waters. They are brough to the sea surface by gradual raising of the sea water. This process called 'upwelling'. According to certain oceanographers, if a pipe lowered to 6,000 feet, it would nee only a little pumping up through to start a perpetual artificial 'upwe ling'. This is because, in the depth water will be cooler and denser. A it rises up, the pipe water will g warmer and less dense than the wat outside the pipe. So it would the rise on its own account and the precess will go on automatically. Th seems to be a simple method for cre ting upwelling. But, may be bec use of the practical difficulties, not has tried it so far.

Minerals are the foundations of which industrial nations are build Oceans contain many types of minerals in immense quantities. Valuable metals, oil and natural gas are a found in the oceans. For their extraction, new types of machines are technologies are already being developed. Offshore wells supply 20 of the world's oil and 7% of its geneeds today. By 1980, it is expect that 30% of the oil will be obtain from offshore wells.

Culturing organisms which cocentrate valuable chemicals like in dine, nickel, cobalt, cerium, van dium or molybdenum in their bod and then harvesting these biologic ores is another interesting prospe Water is the most important source from the sea for living bein on earth. Fresh water from the sea can be obtained by desalinating using nuclear power is in progress the world. Drs. William Campbell of Wilford Weeks of U.S.A. have aggested a very interesting idea to a fresh water from the sea. Large serts can be made to bloom if their ea is adopted in practice. Their ethod is to utilize the icebergs of the retic and Antarctic ice caps. According to them the large icebergs which inge the Antarctic continent can towed by ships to regions where e fresh water supply is poor.

One day, mankind may be able to e the energy stored in the as rather than in the oil and is deposits beneath. Today, tides the mouth of the Rance river oduces 240 Mw of electricity a year. The National Commission on Scince and Technology (NCST) of idia has made a detailed study on e possibilities of tapping tidal ower from our coasts.

The temperature difference beten the upper warm and lower
ld marine waters can be successlly converted into electrical ener. An easily vaporizing liquid—
e ammonia or the commercial
frigerant Freon—could be passed
rough a closed loop of pipes suberged in the sea. In the warmer
ater near the surface, it would be
porized: at depth, it would be
quefied again. The result: a conquous flow that could drive a turegenerator. And another advanege: it would be pollution-free

Another interesting proposition is mming the sea to prevent harml currents. The northern states of usia are covered with ice for most the year. For utilising these herian wastes for agricultural purses, the ice which accumulates here is to be melted. The energy resired for this is beyond our imaginion. But Russians have found easy solution to this problem.

Let year planning to put a dam ac-

ross the Berring Straits between Russia and Alaska, and to pump the cold water out of the Arctic into the Pacific. This would make warm waters to flow the the Arctic from the Atlantic and would melt the polar ice cap. In three years the water temperature in the region would rise to 8°C and would enable vast new areas of Russia to grow plants. But there would be dangerous side-effects also. So it is doubtful whether this scheme would ever be transformed into reality.

Domestication of marine mammals like dolphins to assist man in the oceanic depths is another possibility of the future.

If the population on earth continues to increase at the present level, each man will have only a square meter of living space on land at 500 years. So it is reasonable predict that in future there will under-water cities and industr complexes for extracting the mine wealth of the oceans.

Man has always considered ocea as a common property. Even day, in general, this concept rema intact. As the exploitation of sea-bottom riches starts there v be some sort of struggle to poss the bottom lands unless suital agreements are reached between The maritime nations. Unit Nations Organisation is alrea considering the question of interi tionalization of the sea-beds.

P.G. JAC National Institute of Oceanograp

How water meter works

Lis present in those houses where water is supplied through pipes. But unlike energy meter, it lies somewhere hidden in a corner of the building—connected at the main supply of water to the building. Sometimes it is also independently used in each flat. It is employed not only for measuring the flow-rate of water in homes but also in factories. The flow-rate is usually steady and low in homes, but is high and fluctuating in factories.

A 'drum type meter' is employed wherever there is a low flow-rate of water. viz., homes. In factories, usually a 'Woltmann meter' is utilised.

Rate of flow meter

Employed wherever the flow-rate is high, this type of meter consists

basically of a propeller which rotat when water flows across it. counting mechanism directly recorits rotation rate through worm gea It is apparent that the number rotations of this propeller accoun for a fixed amount of liquid flow For instance, if five rotations are r corded per minute, there is a corre ponding flow of fixed gallons of wat per minute. So, while manufacturin the dial is directly calibrated in tern of gallons. Hence, the reading of th dial gives the rate of flow of water when measured with respect to tim This meter is called 'Woltman water meter.'

For household purposes, where the flow-rate is low, an impaller type of water meter is utilised. It also comprises of a propeller which moves due to the flow of water, and while doin so drives out water to the outlet. It is

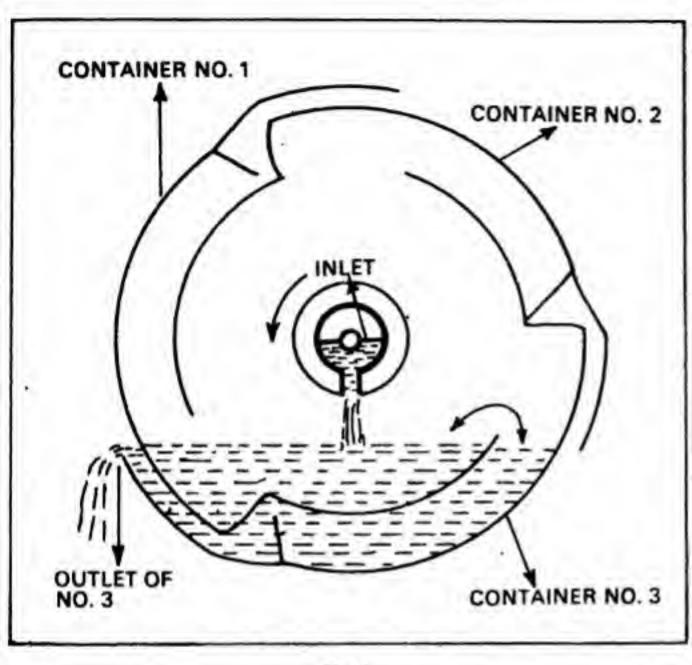


Fig. 1

two types: one in which the countng mechanism is placed in a dry
hamber, but the rest is immersed in
rater. In the other, all parts are
mmersed in water. The latter has
reater accuracy, but its drawback
the sticking up of dirt present in
vater to its dial and other components.

olumetric meters

These meters are employed for the courate measurement of very low ates-of-flow. In this type, there are otating compartments or containers Fig. 1), each having a fixed capacity. Through an inlet water falls into a container, and flows out via an outlet when the container is full. This-procedure repeats in a cyclic ashion in all the containers. The commonly employed meter for such columetric measurement is the 'drum ype meter'. It comprises of three containers with an inlet for water at

the centre. Water falls into the container which is very well below the inlet, and as the container I fills up it becomes heavy and therefore pushes the container 3, which during this period empties itself. Subsequently, container 1 replaces 3, and, in this manner, others are similarly displaced. Container 2 then comes below the inlet, and water starts pouring into it. As the quantity of

water increases, it starts lowering down into container I, pushing the water out. This process continue i.e., 2 replaces I, and so also the others do in a cyclic manner. Whithis continues, the slow circulato motions of the containers a recorded externally, and the rate flow is measured in fixed volumes water.

Venturimeter type

Every science student is well a quainted with the venturimeter tul -a long tube with a constriction the middle. When a steady flo of water is regulated through the tub it is apparent that at the cross-se tions A and B (Fig. 2), the flo velocity is the same but at a narrow cross-section, C, the flow velocity The increase in flo higher. velocity at the constriction leads the lowering of pressure in accor ance with the 'Bernoulli's principle So if manometers are installed these three cross-sections A, B as C, it is found that the manomet readings at A and B are same, wh at C it is different. Since it is know that there is a correlation between the difference in pressures at A as C with the flow velocity of water the knowledge of the pressure diff rence tells the flow-rate of wat through a pipe.

DILIP M. SAL

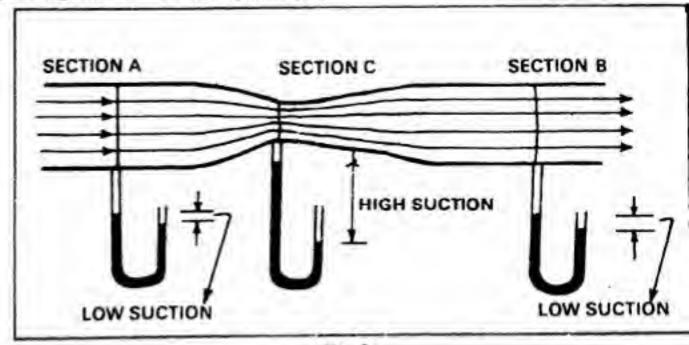
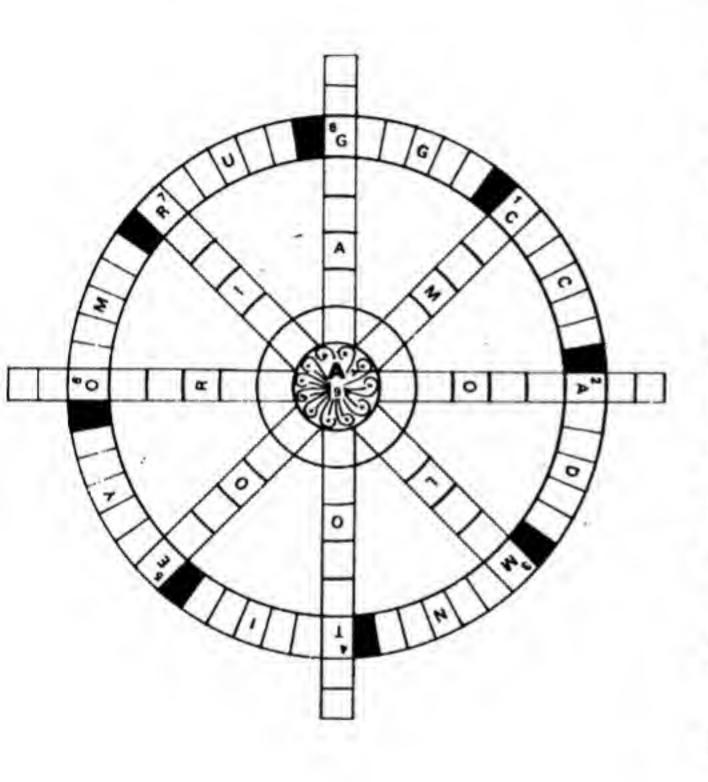


Fig. 2,

Science wheel-word puzzle (chemistry)



Clues

The rim: (clockwise)

- 1. A deadly disease
- 2. A pear shaped distillation vesse
- A characteristic deposition voltage of the metal
- 4. A kind of thermoplastic
- 5. A kind of protein compound
- A process for the production of pure acetic acid
- A name known for idea behaviour
- 8. Inventor of a counter

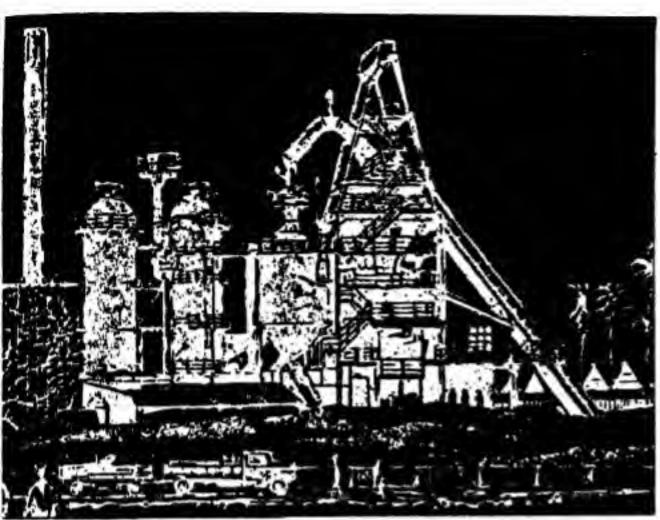
The spokes: The words begin from the common axle clue no 9.

- An old type of retort with a removable cap and neck
- A vessel in which substances may be heated under pressure
- 3. An alloy of mercury
- 4. A hydrometer for oils
- A sealed glass container which guards substances from atmosphere
- 6. Devoid of regular structure
- One of the pair of substances whose space formula is the mirror image of the other
- 8. A strong mixture of strong acids

PRABHAKAR BELAVAD Deptt. of Chemistry P.G. Centre, Gulbarga-6 (Karnataka)

CORRIGENDUM

In "Is rice taboo for the diabetic", Table V, in S. R., November 75, read 7 gm. in place of 26 gm.



SCIENCE IN INDUSTRY

Lead extraction technology

THE National Metallurgical Laboratory has successfully developed a simple and economical process for extraction of lead metal from the lead concentrate of any chemical composition. Apart from being simple and economical, the process is technically sound, feasible in small and big scale sectors and is flexible as far as the mode of energy for smelting is concerned.

Process parameters

It is well-known that some metals can be produced by metallo-thermic techniques in which a more reactive metal serves as a reductant for extraction of a less reactive one. By heating a mixture of the reductant metals and the compounds of the metals to be reduced to a desirable temperature, a reaction sets in by

which there is an exchange of radicals, and the desired metal is liberated from its compound form. The process as developed at the NML seeks to derive the benefit of this principle to extract lead by a cheap and effective reductant by not only liberating the lead in its metallic form, but also converting the metallic lead into a commercially useful sulphide, thus retaining the sulphur in a usable form. Further, there is no need of roasting and sintering and dust catching equipment in this technique, so avoiding air pollution from sulphur dioxide and lead fumes.

The lead concentrate is mixed thoroughly with the reductant and some fluxes, and smelted in a crucible furnace, verticle shaft furnace or electric furnace without any contact with air. The process can be batch as well as a continuous one depending upon the furnace of smelting and its capacity.

Economic feasibility

Techno-economically feasible on small and big scale, the process is yielding the metallic recovery of lead to 90%, which is higher than the recovery obtained on the commercial operations following the conventional practices.

The lead metal produced by this process is having purity above 99.5% and carries entire silver present in the concentrate, which can also be recovered usual conventional methods. Another advantage of this process is that in a single step the lead is recovered in a metallic form and the sulphur retained in the slag mostly as a sulphide of the reductant metal. The costly investment of a blast furnace and sintering units is also avoided in this process. Any source of energy cheaply available at the site of the plant such as gas, coal and electricity can be used

Table. 1. Present consumption and total requirements of lead in India i estimated as follows

			1972-73 1978-7 (Tonnes)	
DGTD			47,500	79,70
Steel			480	85
Small scale industries			16,000	21,40
Defence and allied			10,000	16,00
	7.0	TOTAL	74,000	1,18,00

or smelting by this process. The product has also very successfully been extruded into lead pipes for commercial use.

Based on the successful work done it the NML, M/s. Hindustan Copper and the NML, M/s. Hindustan Copper and the lead contentrate from their recently inauturated plant at Bandala Muttu, andhra Pradesh, having a capacity of 10 tonnes of concentrate per day, the concentrate assaying 50-55% and.

Besides Hindustan Copper Ltd., nany other units such as Sikkim Mining Corpn. which is also a producer of lead concentrates will eventually be interested to take up the know-how for recovery of lead, the bulk requirement of which at present is being met by imports. (see Table. 1)

Against the above figures of present consumption, the smelter at Tundu, a unit of M/s. Hindustan Zinc Ltd., is at present producing around 5,500 tonnes of lead per year and the remaining demand is met by imports. In 1972-73, the lead metal worth of about Rs. 60 crores was imported.

are thoroughly mixed in a ball m to prepare smooth magnetic pair The magnetic paint so formulate is kept inside the coating chamb and continuously stirred. The re base material such as mylar passed through the coating chan ber where a uniform coating of ma netic paint is applied to one side the film. The coated film, still we is passed through a magnetic fie for alignment of magnetic particle The aligned and coated film finally drawn through the dryin chamber, where it is dried price to rewinding on suitable fo mers. Finished roll is polished ar is then ready for slitting. The sli ted magnetic tape is finally wour on spools.

Large quantities of tapes have been produced on the experiment plant of the Laboratory. The tape have been vigorously tested and the conform to IS specifications. All the raw materials are indigenously available except gamma ferric oxide an polyester film. The equipment an machinery for the plant is indigenously available or could be fabricated in accordance with NPL design

Magnetic tapes for cassette tape-recorders

manufacture of magnetic tapes or cassette tape-recorders has been eveloped by the N.P.L., New Delhi.

tapes are being imported resulting in drain of a few crores of rupees in foreign exchange.

The ingredients like gamma-iron oxide, binders, resins and solvents

BOOK REVIEWS (Continued from page 192)

short span of seven years it has one through four editions. The itest edition has several changes wer the earlier editions both in conents as well as in the format. Apart com new experiments, a section on SI units has been added to familiarise the student with their usage. Another welcome change is in the printing. Unlike all the three previous editions which were brought out in a typescript form by offset, the present edition has been printed b letter-press. This has improve the overall readability of the text.

> 7UF, College Roa New Delhi-11000



ENERGY UNDER THE OCEANS by Don E. Kash and others, The University of Oklahoma, 73069, USA, Pp. 400, \$ 4.50

THIS is a report of technology assessment of oil and gas operations on the U.S. outer continental shelf made by an interdisciplinary research team under the aegis of the Science & Public Policy Programme at the University of Oklahoma.

The USA is today the most exhausting user of energy. The demand for energy in 1985 is estimated at 23 million barrels of oil per day and 36 trillion c.ft. of gas per year. Together, these sources are expected to satisfy about 70 per cent of the total demand. To meet the growing deficit, the USA is turning its attention to the outer continental shelf (OCS) for oil exploration. The OCS represents the submerged lands extending from the outer limit of the territorial sea to some undefined outer limit which in the USA is the portion of the shelf under federal jurisdiction. Till 1971 cumulative offshore production in USA was 4.8 billion barrels of oil and 20.7 trillion c.ft. of gas. Here in this volume the authors give a critical assessment of the potentialities and pitfalls of exploration in OCS and the economics of the project.

Systematically, the volume deals with the background study, the social aspects and repercussions, the physical technologies used in OCS drilling, and objectives in planning for protecting and restoring the environment, which have a significant bear-

ing on general administration.

The text should interest the geophysicist and petroleum technologist in knowing the latest methods of offshore exploration; the administrators and policy-makers in learning how such aspects can be handled and the economics of the problem; and the environmentalists in studying the manner in which full protection and safeguards can be maintained during oil and gas exploration.

S.K. GHASWALA

ADVANCED INORGANIC CHEMI-STRY by F.A. Cotton and G. Wilkinson, Wiley Eastern Pvt Ltd., J-41, South Extension 1, New Delhi-49, Pp. 1136 (1969), Rs. 22.50.

THE low priced edition of this book is a welcome addition to the text-books of inorganic chemistry. The presentation of a factual subject such as inorganic chemistry has been lucidly done in the book.

The book is divided into three parts. The first part consists of general theories of the electronic structure of atom, the nature of ionic substances and the nature of chemical bonds. A detailed discussion of the chemistry of non-transition elements and their compounds comprises the second part. There is an elaborate discussion on the chemistry of carbon and silicon which is usually meagre in the contemporary inorganic textbooks. The third part starts with an introductory survey on the transition elements. It includes a discussion on the electronic structures of transition metal complexes, complexes of w-acceptor ligands, and organometallic compounds of transition metals. The chemistry of individual elements of the first, second and third transition series is highlighted. This part also includes two separate chapters on the lanthanides and the actinides.

The book is particularly good for the study of coordination compounds. The discussion of the chemistry of coordination compounds begins with a very general definition and this is followed by an easy-to-comprehend and non-rigorous treatment of molecular orbital, valence bond and ligand field theories. In addition, the merits and demerits of these theories have been discussed.

A correlation between atomic structure and the chemistry of compounds has also been sought wherever possible with the help of a variety of physicochemical data. This is another interesting feature of the book.

Only the principles, not the details of metallurgy of individual elements, have been discussed. In the recent years, studies on bio-inorganic chemistry are gaining considerable importance; however, this topic has not been included in the book.

This is really a comprehensive textbook for B.Sc. (Hons) and even for M.Sc. syllabi of universities of India. The extensive and up-to-date bibliography is highly useful even for research students.

ALOK R. RAY
Department of Chemistry
University of Delhi
Delhi-110007

INTRODUCTION TO EXPERI-MENTAL NUCLEAR PHYSICS by R.M. Singru, Wiley Eastern Private Ltd., New Delhi, 1974, Pp xii+162, Rs. 9.75

Nucleus of an atom, has been growing at a tremendous rate for the last forty years or so, and with its development a large number of books have been written on the subject. The book in question is a further addition to the already existing long list of books on nuclear physics, but with the distinction of being one of the few written by Indian authors.

Most books treat the subject from the experimental as well as theoretical view points, and the ones which deal exclusively with the exerimental aspects are in the form f edited volumes written by speciasts in the field. A reader, who imply wishes to acquaint himself ith the various methods of experinental nuclear physics, usually finds imself lost in the vast literature hich is often too detailed. The resent book serves a good purpose y introducing most methods of exerimental nuclear physics in an easy nd summarised manner through hich a beginner can acquire enough nowledge to appreciate the adanced texts on the subject.

As a separate branch of physics, uclear physics is introduced in dian universities at the M.Sc. vel. Even at that level, not consiering a few selected institutions here advanced courses are availble in some branches of physics, uclear physics is taught as a single nit, and not as two units (namely, xperimental and theoretical). hough the author claims to have ritten the book for post-graduate nd research students, it appears that his book would be of use mainly to he research workers.

The book is divided into ten hapters. It starts with an introuction to basic properties of nuclei nd with the various modes of decay etween the nuclear energy states. fter summarising some features of uclear reactions, the book passes n to a discussion of nuclear radiaon detectors, then to a discussion f different spectrometers used in lpha, beta and gamma-ray studies. it the end, some special experimenal techniques used in nuclear specoscopic work and some research elds where nuclear techniques form basis of investigation are outlined. on the whole, the book lays more mphasis on measurements dealing ith radioactive decay processes. he book is written in a compact orm in an easy-to-understand lan-

guage. At the end of each chapter, a reference list for further reading is provided.

The book suffers from a few shortcomings as well. Some fields, e.g., nuclear reactions, have not been dealt in detail. Particle accelerators and polarized ion sources, which form the main tools of nuclear reac-. tion work, have not been discussed. All this is surprising in view of the setting up of a variable energy cyclotron at Calcutta and the use of a few Van-de-Graaff accelerators in some institutions in India. The methods of analysis used for extracting useful information from the experimental data needed a detailed discussion in a book of this type. Inclusion of exercises at the end of each chapter would have helped the readers in learning the subject with confidence. Even with such shortcomings, the book in its present form would be a valuable aid to beginners in experimental nuclear physics.

> NARESH KUMAR Physics Deptt., Hindu College Delhi-110007

EXPERIMENTS IN GENERAL CHEMISTRY by C.N.R. Rao and U.C. Agarwala, Fourth Edition, Affiliated East-West Press, 9, Nizamuddin East, New Delhi-110001, Pp. 264+xii, Rs 8.75.

COR a long time chemistry teaching in Indian Universities, specially the practicals, had been a rather tame and routine affair. The most a first year undergraduate was asked to do was mixture analysis. volumetric titrations and a few gravimetric estimations. In most cases the student simply carried out the instructions without even fully understanding the principles or the usefulness of a particular experiment. And

the fault lay not in the student, but the way the subject was taught.

Rao and Agarwala's approach novel in that they have tried present, through a wide selection experiments, a laboratory course general chemistry in a more in resting format. Special care h been taken to avoid unnecessary petition of similar experimen techniques. Several experimen deal with objects of daily intersuch as estimation of the chlori content or hardness of tap water analysis of solder, making of blu prints or artificial silk, preparation aspirin, and so on. Although ea of these has been included to demor trate a particular chemical princip the experiments themselves are de gned to stimulate interest in t student.

The contents, which include experiments, cover a wide range topics: from simple calibration mercury thermometer and purific tion of compounds to experimen for the determination of the size as weight of a molecule. There a also experiments on thermochemist electrochemistry, homogeneous a heterogeneous equilibria, chemic kinetics, chromatography, and course, qualitative and quantitati analysis. For obvious reasons, or semimicro schemes in qualitati analysis are given. The expe ments in quantitative analysis clude complexometric and potenti metric titrations. Quite a fe organic and inorganic preparatio have been included to illustrate t basic processes. Apart from the pr cedural details, the principles inve ved are also explained before ear experiment. Five 'student projec given at the end can serve as a valu ble guide to help students in planni and devising their own experimen

The popularity of the book of be judged from the fact that with

(Continued on page 19

FOR SURE SELECTION IN LI.T.

Read ARUN'S GUIDE

For

INDIAN INSTITUTE OF TECHNOLOGY

(ENTRANCE EXAMINATION)

A guide book covering the complete syllabus as prescribed for the entrance examination of I. I. T. and also based on previous years' question papers fully solved.

1st Edition 1976

Price Rs. 20.00

YOUNG MAN & CO.

888 NAI SARAK, DELHI-110006

Phones: Delhi 263298 Juipur 73972 Bhopal 2500

Copies available with all the leading book-sellers or send your orders direct to the publishers with an advance of Rs. 5,00 by M.O.

INDISPENSIBLE BOOK

FOR

MEDICAL ADMISSION TEST

OBJECTIVE GUIDE

INCLUDING

MULTIPLE CHOICE, THOUGHT, NUMERICAL AND QUESTIONS OF VARIOUS MEDICAL TESTS.

Price: Rs. 25.00 Postage: Rs. 2.00

POPULAR BOOK STORES

OPP. PATNA COLLEGE, PATNA-860004

INDUSTRIAL PERFUMES LIMITED

(A TATA-ROURE DUPONT ENTERPRISE)

Leading Manufacturers

of

PERFUMERY COMPOUNDS
AROMATIC CHEMICALS

for

SOAPS AGARBATTI SNUFF

COSMETICS CHEWING TOBACCO PAN MASALA

etc.

Office & Factory:

Tank Road P.O., Bombay 400033

Phone: 370161

FOR MEDICAL ENTRANCE TESTS

Read

ARUN'S GUIDE

For

MEDICAL COLLEGES ENTRANCE EXAMINATION

Containing

Objective & Thought Type Questions

(FOR A.F.M.C. POONA, C.P.M.T. U.P., VARANASI, ANDHRA PPADESH, VI-LLORE, PONDICHERRY, BANGALORE, MYSORE, BIHAR, ORISSA, ETC.)

7th Revised Edition 1976

Price: Rs. 22.50

and

ALL INDIA INSTITUTE OF MEDICAL SCIENCES

(Entrance Examination)

Containing

Short Answer & Essay Type Questions
(ALSO USEFUL FOR WEST BENGAL, ALIGARII,
M.P., WARDHA, RAJASTHAN AND MEDICAL
COLLEGES OF DELIII. ETC.)

Published by:

Price: Rs. 21.00

YOUNG MAN & CO.

888 Nai Sarak, Delhi-110006

NATION ON THE MOVE

Towards greater comfort and speed

The Indian Railways run more than 10,000 trains every day, with 2,570 sleeper coaches for the long-distance traveller by II Class. And trains are running to time, everywhere. The goods trains carry 5.5 lakh tonnes of freight everyday-essential supplies.

You can help improve the service. Prevent ticketless travel and pilferage of railway fittings.

IRON WILL AND HARD WORK SHALL SUSTAIN US

davp 75/455



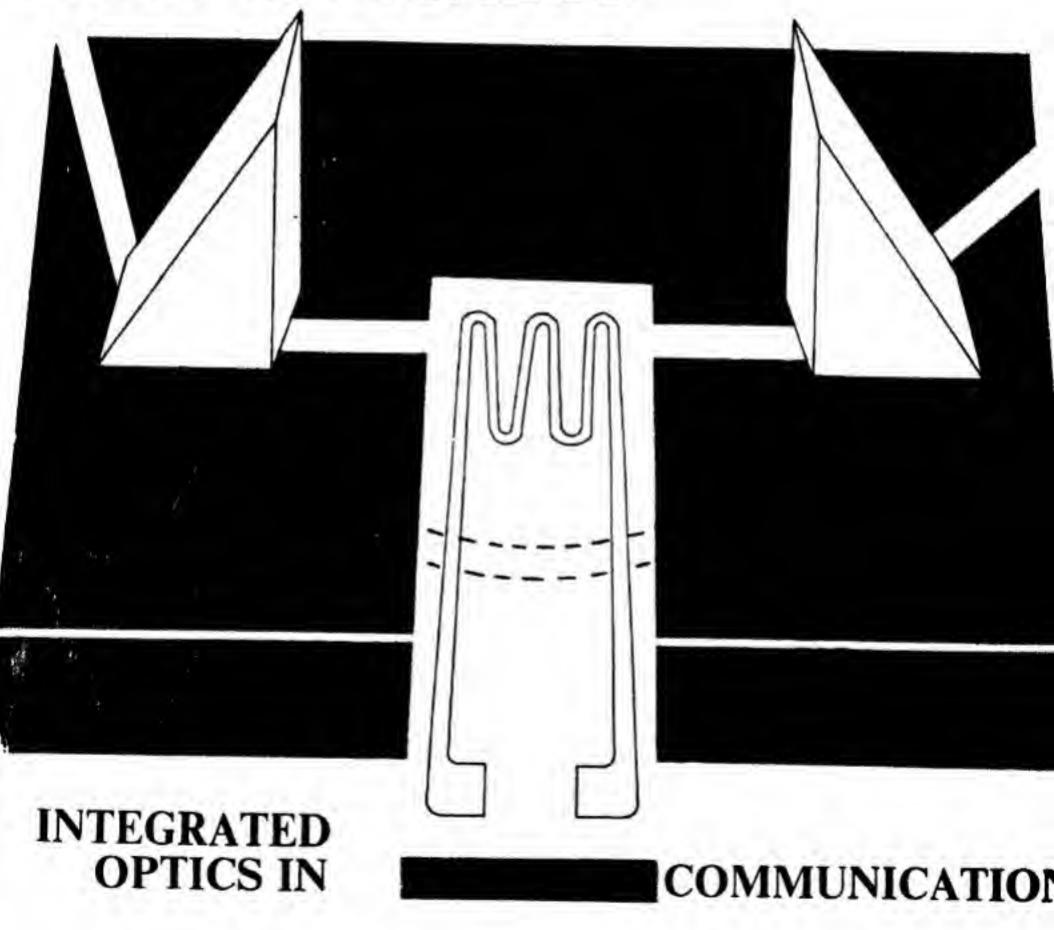
Por a free booklet on RAILWAYS

please write to: Distribution Manager,

D.A.V.P., B Block, Kasturbe Gambe Marg.

New Delhi-110001

SCIENCE REPORTER





Re. 1.00

COUNCIL OF SCIENTIFIC INDUSTRIAL RESEARCH

THE ULTIMATE CONSTITUENTS OF MATTE

METALS IN OUR BODY

ALICORN - A MYTH OR REALITY?

WHAT SHOULD ATHLETES EAT?

WHY DOES YOUR BODY FATIGUE?

FOR SURE SELECTION IN I.I.T.

Read

ARUN'S GUIDE

For

INDIAN INSTITUTE OF TECHNOLOGY

(ENTRANCE EXAMINATION)

A guide book covering the complete syllabus as prescribed for the entrance examination of I. I. T. and also based on previous years' question papers fully solved.

1st Edition 1976

Price Rs. 20.00

YOUNG MAN & CO.

888 NAI SARAK, DELHI-110006

Phones: Delhi 263298 Jaipur 73972 Bhopal 2500

Copies available with all the leading book-sellers or send your orders direct to the publishers with an advance of Rs. 5.00 by M.O.

INDISPENSIBLE BOOK

FOR

MEDICAL ADMISSION TEST OF

POONA, U.P., A.P., M.P., VELLORE PONDI-CHERRY, VARANASI, ALIGARII, BIHAR, ORISSA, BANGALORE, MYSORE, ETC.

OBJECTIVE GUIDE

INCLUDING

MULTIPLE CHOICE, THOUGHT, NUMERICAL AND QUESTIONS OF VARIOUS MEDICAL TESTS

Price: Rs. 25.00 Postage: Rs. 2.00

POPULAR BOOK STORES

OPP. PATNA COLLEGE, PATNA-800004

FOR MEDICAL ENTRANCE TESTS

Read

ARUN'S GUIDE

For

MEDICAL COLLEGES ENTRANCE EXAMINATION

Containing

Objective & Thought Type Questions

(FOR A.F.M.C. POONA, C.P.M.T. U.P., VARANASI, ANDHRA PPADESH, VELLORE, PONDICHERRY, BANGALORE, MYSORE, BIHAR, ORISSA, ETC.)

7th Revised Edition 1976

Price: Rs. 22.50

and

ALL INDIA INSTITUTE OF MEDICAL SCIENCE

(Entrance Examination)

Containing

Short Answer & Essay Type Questions
(ALSO USEFUL FOR WEST BENGAL, ALIGARH,
M.P., WARDHA, RAJASTHAN AND MEDICAL
COLLEGES OF DELHI, ETC.)

Published by:

Price: Rs. 21.0

YOUNG MAN & CO.

888 Nai Sarak, Delhi-110006

IT PAYS

TO

ADVERTISE

IN

SCIENCE REPORTER

ARJUNA THE SKILFUL AND ACCURATE ARCHER

The matchless skill of Arjuna won for the Pandavas many victories.
His accuracy with the bow and arrow was so reliable that people placed him in a class above the rest in his field.



and Reagents stand for matchless accuracy and purity. No wonder, therefore, that people who do not compromise on these qualities put Duchen Laboratory Chemicals and Reagents to extensive use in Research, Education Analysis and Industry



to our contributors

- SCIENCE REPORTER welcomes articles of absorbing interest on science and technology. Contributions
 published in the Journal will be paid for.
- Articles should be sent to the Editor, SCIENCE REPORTER, CSIR, Rafi Marg. New Delhi-110001.
- The form and manner of presentation of the subject should be easily understandable to the undergraduate level.
- The length of the article, written exclusively for the Journal, may be about 2500 words.
- The matter should be typewritten, double space on one side of the paper; the original and a carbon copy are to be sent.
- The article should preferably be illustrated; captions and legends typed separately and attached at the end of the article. Photographs should be on glossy paper.
- While quoting names of scientists, etc., their initials, nationalities and periods of research under reference should invariably be mentioned. All weights and measures should be given in Metric Units.
- A short note about the contributor should also accompany the article. The note should contain age, academic accomplishments, important assignments held, fields of research and hobbies.
- Articles or illustrations published in the Journal can be reproduced with permission of the Editor.
- The Editor reserves the right to reject even invited articles without assigning any reason.

SUBSCR	IP	TI	0	N
FORM				

To

The Editor
SCIENCE REPORTER
C.S.I.R., New Delhi-110001

Name	_0 10-10	
Full Address		
(in capitals)		
PIN	H	
(Old Subscription No)	Signature	
NOTE: Please mention old Subscription No in M.O. com	pon also.	

SCIENCE REPORTER

VOL. 13 APRIL 1976 NO. 4

196 LETTERS

199 PLANETS AND THEIR POSITIONS—MAY 1976 MAIN ARTICLES

200 Are quarks the ultimate constituents of matter?

201 Integrated optics in communication

202 Chemical reactions—the spirit of chemical science

203 Chemical reactions—the spirit of chemical science

206 P.V. Rama Sastry

207 M. D. Mishra & P.

216 Metal ions of life P.P. Singh

220 SCIENCE SPECTRUM

The Interplanatary space—The leap second—Separation of isotopes usin laser—Single photon processes—Mercury pollutes the environment. Alicorn or the horn of the unicorn—Thymus plays a vital role in our body. Diet for athletes—Liver detoxicates drugs—Electrical events in the orig of heart diseases—Body fatigue—Pets can be dangerous

246 NEWS AND NOTES

Nobel physicist Hertz is dead—Evolution of man in Africa — Medicine Nob list Dr. Whipple passes away

247 MEDICAL NOTES

Cromolyn—a new drug for asthmatics—Loss of ascorbic acid (Vit. C) diseased plants

249 SCIENCE FOR THE YOUNG

Big and small numbers-Pens: their development and working-Ho sago pearls are formed-Believe it or not

254 SCIENCE AND INDUSTRY

Fly ash for reinforced and prestressed concrete—Economic significance lotus (Pamposh)—High protective enamels for aero-engine components

256 BOOK REVIEWS

Photosynthesis-Human Physiology-The Mechanism of Body Function

Annual Subscription

cience Reporter is issued monthly. he Council of Scientific & Industrial esearch assumes no responsibility

r the statements and opinions

ivanced by contributors.

mland : Rs. 10.00

Foreign: \$ 5.00

Editor: S.P. Ambasta Asstt. Editors: C.B. Sharma, Zaka Imam

Editorial Staff: Dilip M. Salwi, Nisha Misra Sales & Advt.: G.N. Jaswal, G.E. Salpek
Production: V.S. Chaturvedi



Antitranspirants

Sir, The author (S.R. November, 75) has repeatedly described phenylercuric acid as an antitranspirant, t to my knowledge such an acid es not exist. Perhaps he has in mind enylmercuric acetate and has stad that this acid damages the toliage blocking photosynthesis. I would e to know if the author has gone rough the papers of D. Shimshi, ant Physiol, 38: 709-721 (1968). A. Siegenthler and L. Packer, ant Physiol, 40: 785-791 (1965) d Physiol. Planta, 17: 437-447 966). Dr. Sadhu has suggested at there are almost limitless possible es of antitranspirants in agriculre and has further stated that t much work has been done in dia. Is he aware of the works iblished in Bot. Mag. (Tokyo), 81: 9-225 (1968), Biochem. Physiol. Panzen, 161: 532-536 (1970) and ant Physiol., 50: 271-274 (1972) B out the research done in India by me Indians? These researches ive stressed whether antitranspints increase drought avoidance drought tolerance of crop plants, eds further experimentation. Somenes growth retardants are used transpiration suppressants (Nature, 6: 310-311, 1963; Israel J. Agric. es., 14: 153-158, 1964; Annu. Rev. ant Physiol., 15: 271-302, 1964). here is no mention in the article of e growth retardants as possible titranspirants. A large number of ientists have reported that transpiration can be suppressed by the use of chemicals but they cannot be used in practical agriculture. Most of the work on antitranspirants is of academic interest so far as stomatal control is concerned and I have my personal doubts about the author's statement,"....we have before us a very exciting field of research to study the significance of reduced transpiration in modern agriculture."

MANORANIAN KAR Deptt. of Botany Utkal University Bhubaneswar

I regret the typographical mistake which appeared in my article. I also thank Shri Kar for drawing our attention to it. There is another printing mistake. The readers should read phloem for phyloem in Fig. 1. I have not said in my article that no work has been done in India. I have only stated that not much work has been done in this country, although there is a great scope. It has also been mentioned in my article that many spray materials including herbicides, fungicides, metabolic inhibitors and growth regulators can induce stomatal closure and this may effectively reduce transpirational water loss in plants. There was not much scope in my article to discuss the effects of all the chemicals which have been The used as antitranspirants. growth retardants, however, may well be included in the category of 'growth regulators'. I have also indicated in my article that an ideal antitranspirant is yet to be developed. If such a substance is developed, it will definitely be of great use to agriculturists.

M.K. SADHU
College of Agriculture
University of Calcutta
Calcutta 700019

Sunflower

Sir, Sunflower, an ideal source of oil (S.R. Nov., 1975) was informative but the following contradictory state ment is observed.

Under the heading "Quality of sunflower oil", the information gives is that sunflower oil has a rich content of linoleic acid (68 per cent which reduces the amount of choles terol in the blood. But the last par says, "sunflower oil has an exceller shell life due to near or complete absence of linoleic acid."

S.B. REPAL Tech. Superviso C.T.A., Kirk

The last para should read "sunflower oil has an excellent shell-life du to near or complete absence of linoleic acid."

RAJINDER SING Soyabean Production Office Soya Production & Res Association, Bareilly (U.P.) 3

Blood groups

Sir, In the article Blood groups and diseases (S.R. June, 1975), Dr. Base has laid much emphasis on Rh blood group neglecting the importance of A-B-O groups in transfusion

During incompatible transfusion there occurs an agglutinogen-agglu tinin reaction, e.g., cells having 'agglutinogen A' will react with serum 'agglutinin ante-A' or ∞(alpha leading to agglutination. The reac tion takes place because serum agglu tinins acts as antibodies and hence react with agglutinogen. Similarly cells with 'agglutionogen B' wil react with anti-B or β-agglutining Therefore, in order to avoid aggluti nation, a person of type A aggluting gen will be having β -agglutinin and in the persons of type B agglutino gen, ∝-agglutinin will occur. Typ AB blood contains no agglutini and type O blood contains bot agglutinins.

Obviously, if the serum from person of type A is mixed with th cells of a person of type B, aggluti nation will occur, while no suc gglutination occurs if added to ype O cells. However, it seems hat the isoagglutinins of the donor type A blood) do not agglutinate he cells of the recipient because dotor's isoagglutinins are well diluted by the time they have mixed with the recipient's circulating blood.

Since type O blood cells are not gglutinated by any of the isoaggluinins, this stype is called 'universal onors' and conversely persons with ype AB blood are called 'univeral acceptors'. The use of such erms is, however, deceptive because ertain people of type O blood posess a very high concentration of c or β-isoagglutinins and even after ransfusion, there may be a high mount of ∞ or β -isoagglutinins react with the recipient's cells. his risk is avoided by a process alled 'cross matching' in which onor's cells are treated with reciient's plasma to see whether agglunation occurs or not; if it does, the ilution factor of plasma is taken no account.

UPLNDER K. WALI Govt. Medical College Srinagar

Fuel of the future

Sir, In Hydrogen—the fuel of the sture by Dr. Sen Gupta and Dr. alit (S.R., Oct., 1975), there are no unbalanced sequences:

aBr_s + 2H_sO→Ca (OH)_s + HBr at 750°C), and

 $Fe_3O_4 + 2Cl_2 + 12 \text{ HCl} \rightarrow 6FeCl_3$ - $6H_2O + O_2$ (at 150°C-200°C).

In fact, these sequences are aBr₂ + H₂O→Ca (OH)₂ + 2 HBr at 750°C), and

Fe₃O₄ + 3 Cl² + 12HCl→6FeCl₃ -6H₂O + O₂ (at 150°C-200°C)

I would like you to publish an rticle on liquor ammonia.

VASUDEV JADHAV Vellur (Belgaum)

Believe it or not

Sir, Dr. Khan has stated (Believe or not, S.R., Jan., 1976) that even

though the earth is in motion around the sun with a fantastic speed of I lakh km/hr, this high velocity is not noticed because human beings are sensitive only to acceleration and deceleration. Now it is known that the orbital path of the earth is an ellipse with an eccentricity of .016726. This gives the ratio of maximum to minimum velocity as 1.03402. So, the earth is accelerating as well as decelerating. I would very much like to know why this acceleration and deceleration is not felt by us.

The significance of the inset picture is also not very clear.

S.K. GURTU
Defence Sc. Laboratory
Metcalfe House
Delhi-110054

Non-Euclidean geometry

Sir, I read the article History of non-Euclidean geometry by Jyotirmoy Hui (S.R., Nov. 1975); The article is very well-written and even a non-mathematician (whose knowledge is limited to school geometry) can get an idea of the development of non-Euclidean geometry and can see how Euclid's "parallel postulate" was modified and how different types of geometry were invented by mathematicians. The imporatnce of "parallel postulate" and the difficulty of its replacement by another postulate and the fundamental difference between Euclidean and non-Euclidean geometry have been clearly expressed by the writer. As an expository article, the language is very lucid and the history of development of geometry from the ancient time is quite interesting. It would be of great help to those who want to know how non-Euclidean geometry came into being. It would have been better if the writer had given some references.

N.D. CHAKRABORTY

Assistant Professor of Mathematics

Presidency College

Calcutta

Removal of patella

Sir, Resulting from an accident one of the kneecaps or the patella of a man is completely damaged (broken into pieces). The patient requires to be operated upon for removal of the damaged patell Some are of the opinion that the removal of patella will not impate the walking capacity of the manather it will help him run faste Does this belief has any scientification. If that he so, why are the persons desirous of running faste not advised to get their patella removed surgically?

P.O. Boincheegran Dist. Hooghly (W.B.

Treatment facility for sickle

Sir, My thanks to Partha Pratir Majumdar for his letter (S.R., Jan 1976) on sickle cell anemia statin that this disorder can be treated. M two and a half year old son is suffering from sickle cell anemia. I consulted specialists but they told m that there was no specific medicin for it. I shall be thankful if an reader informs me where I can ge my ailing son treated.

S.K. PARGANIH. Q.No. 1243, Sector I R.K. Purar New Delh

Cosmology

Sir, Of late you have been publish ing interestir . i. of article on cosmoly a thick, Pende S.R. Anns Qual for sould 1977). Dr. V B. Line at The ritt of the universe Si. Den : 1975) and D. '1 Salare | ar. tier . 1 1 10 1 170 ar. ie, and th · we' wientiff best kne Picas keer

A detailed article on the Project Dama and the Project Cyclops menioned in Shri Salwi's article would be of much interest to the readers. Similarly detailed articles on the rigin of the solar system, man's hanging vision of the universe, role of meteorites in giving a clue to the extra-terrestrial life, possibility and problems of the interstellar communications, etc., would form ood sequel to the present series.

Among the books on extra-terresrial life, Walter Sullivan's We Are
Not Alone (Penguin) is a very
copular and interesting account of
the subject. On cosmology in geneal, Dr. Jagjit Singh's Modern Cosmoogy (Pelican) is also a readable
ook which even a layman without
nuch scientific background can grasp
and understand.

S.B. SINGH L.I.C. of India, Bajaj Road, Sikar (Rujasthan)

Sea turtles

With reference to Shri P.G. Jacob's formative article Turn of the artles (S.R. Feb., 1976), I'd like make a few comments. A I cm deep nest hole is dug with the emale turtle's hind flippers. The ggs hatch in about 60 days after layng. Since they generally hatch and nter the sea at night their main redators are not birds but crabs and shes. The Govt. of India closed the xport of sea turtles in April 1975 ince all are listed in the Red Data look of the International Union for onservation of Natural Resources s rare and endangered. At least ntil population studies are underken on "luxury protein" animals ke sea turtles and frogs, export to rotein rich countries should be anned.

The Olive Ridleys sea turtle lays its eggs all along the East Coast (Dec.-Mar.) and some parts of the West Coast. The eggs have been over exploited almost everywhere and, because a number of breeding and nesting turtles are drowned incidentally in offshore trawling nets, this species is obviously diminishing.

The author states that in the year 1967-68 "tortoise shell" exports were 60,345 kg worth Rs. 16,770. That comes to 28 paise per kg. probably about one twentieth of the actual wholesale value!

Wildlife farming may be one of the only answers to the survival of many species. Mariculture Inc. is not breeding sea turtles, it is hatching wild collected eggs and rearing the young to slaughter size. In other words they are "mining" and not farming, the wild life population continues to dwindle. We have maintained India's first sea turtle hatchery (for release) for the past three years and have released some 5,000 hatchlings. Interested readers are invited to contact us.

ROMULUS WHITAKER Hon. Director, Madras Snake Park Trust & Conservation Centre Madras 600022.

I think it is necessary to clarify some of the points raised in Whitaker's letter.

- 1. The most important commercial turtle species in India is the green turtle, Chelonia mydas, and not Lepidochelys olivacea (Olive ridleys). Further, because of the disagreeable flavour of the meat Lepidochelys is not very much relished. So, the species which I have given most importance in my article is Chelonia mydas and the descriptions are applicable to it.
 - 2. Regarding the closure of sea

anything. But kindly permit me quote the following line: "Therefor it could perhaps be estimated that to catch of 3,500 turtles could be h from the Palk Bay and the Gulf Mannar at a sustained leve (Dr. S. Jones, former Director Central Marine Fisheries Research Institute).

- Sea turtles and frogs cann
 be equated. Sea turtle meat is n
 a "luxury protein".
- 4. Value of I kg of "tortoise shell was about 26 paise during 1968 During 1968 and 69, the values we about Rs 13 and Rs 20 per kg.

 October, 1975 it was Rs 185.60 kg.

 These figures show that the value not constant. For further clarications kindly go through reference 2, 3 and 4.
- 5. I have not stated in my artice that Mariculture Inc. is breeding startles. They, of course, collect egifrom nature and rear the young slaughter size. Further, they return a portion of the young ones hatche from the collected eggs to the sea conserve the species. Therefore, is not correct to state that they a mining the turtle resources. It more correct to say that the are trying to domesticate the seturtles.

P.G. JACO National Institute of Oceanograph Go

Welcome additions

Sir, Believe it or not is an exceller addition and is helpful to the young Cartoons also provide good inteller tual humour. Many thanks for these new additions.

> DHARAM PAL SING Meerut Colleg Meerut (U.P

Planets and heir positions

MAY 1976



PLANETS MARS SATURN MAGNITUDES 0 1 2 3 4 3

MOON

FIRST QUARTER 7TH

O FULL MOON 14TH

The moon

Full moon occurs on 14th at -35 a.m. and new moon on 29th t 7-17 a.m., 1.S.T. The moon asses about four and half degrees outh of Mercury on 1st, seven degrees south of Mars in the evening of th, five and a half degrees south of aturn on 6th, and about a degree orth of Jupiter on 27th. The lunar rescent becomes first visible after

the new moon day in the evening of 30th.

The moon is at perigee or nearest to the earth on 12th and at apogee or farthest from it on 25th

Lunar eclipse

There will be a partial eclipse of the moon in the early hours of 14th. It will be visible in India. The eclipse would begin at 0-46 a.m. and end at 2-03 a.m. I.S.T.

An occultation of the star Spica (Chitra) by the moon will occur in the early hours of 12th. It will be visible at Bombay from 3-05 to 3.37 a.m. and at Madras from 3-12 to 3-50 a.m. 1.S.T.

The planets

Mercury (Budha), an evening star, sets about an hour after sunset during the first half of the month. Thereafter, it is too near the sun to be visible. It will be in inferior conjunction on 20th. It becomes retrograde on the 9th. It is in Taurus (Vrisha). Its visual magnitude varies from +0.9 to+2.

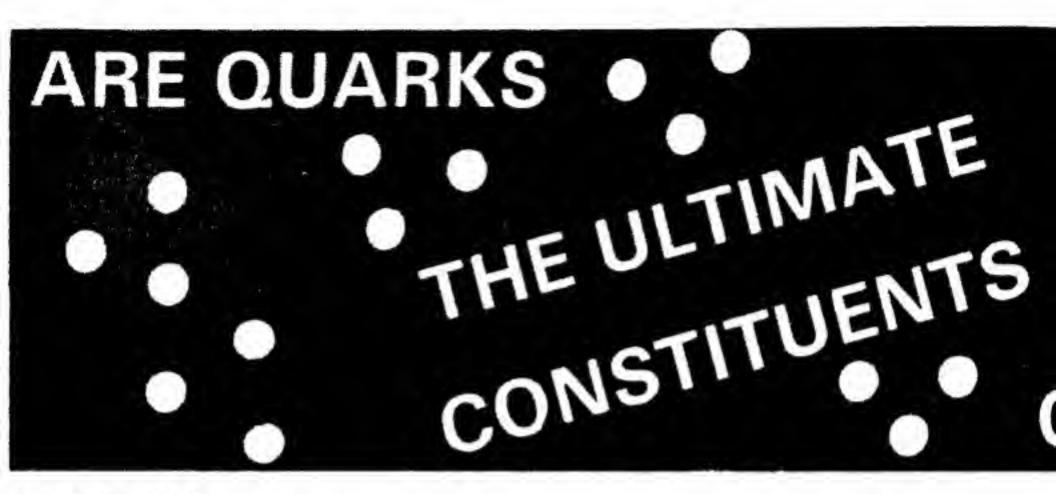
Venus (Sukra), a morning starrises about half an hour before sunrise during the first half of the month Thereafter, it is too near the sun to be visible. It passes about quarteof a degree south of Jupiter on 11th It moves from Aries (Mesha) to Taurus (Vrisha). Its visual magnitude is about -3.4.

Mars (Mangaia), visible in the evening sky, sets about an hou before local midnight during the month. It passes about five degree south of the star Pollux (Punarvasu on 5th and about one degree north of Saturn on 12th. It moves from Gemini (Mithuna) to Cancer (Karkata). Its visual magnitude i about + 1 6.

Jupiter (Brishaspati) is too near the sun to be visible during the first half of the month. Thereafter, is reappears in the morning sky and rises about an hour before sunrise. It is in Aries (Mesha). Its visual magnitude is about -1.6.

Saturn (Sani), visible in the evening sky, sets about an hour before local midnight during the first hal of the month and about two hourbefore it during the second half. I is in Cancer (Karkata). Its visual magnitude is about +0.4.

(Source: Nautical Almanac Unit of the Meteorological Office, Alipore Calcutta-700027).



D. PARASHAR B.L. ARORA

THE problem of understanding the structure of matter has engaged the attention of scientists ill over the world for several centures. In the old days, matter was hought to be composed of indivisible mits called "atoms". The pioneering work of J.J. Thomson and Lord Rutherford at the beginning of this entury revealed that the atoms hemselves were composites of still maller units. The atom consists of a heavy positively charged nucleus with electrons revolving round it in closed orbits. The nuleus itself consists of smaller entities. iz., protons and neutrons. Until a ecade ago, the protons, neutrons and electrons were regarded as elementary particles' in the sense hat they could not be successfully escribed as composites. During the ast few years, a large number of lementary particles have been disovered by various experiments. In arly 1960, the number of elementary articles known was about thirty. t present, there are as many as our hundred of such particles with

Many models have been suggested to incorporate certain minimum number of particles states out of which others could be easily constructed. The most successful of the composite particle pictures is the 'Quark Model'

an equal number of antiparticles.

A number of attempts have been made to study the properties of the elementary particles in a coherent manner. One important aspect of the modern view of the particles is a clear distinction among different types of interactions that govern their behaviour. These interactions are classified as: (i) strong (ii) electromagnetic (iii) weak and (iv) gravitational in descending order of strength. The strong interactions represent the forces that bind together the particles in the nucleus. The variety of elementary particle states determined by this interaction are collectively referred to as 'hadrons'. The hadrons are further divided into two categories: 'baryons' which include nucleonic-type particles (viz., protons, neutrons, etc.) and 'mesons'

which act as transmitters of strong interactions. The transmitters of electromagnetic interactions are the well-known light quanta, viz., photons. The decay of all these elementary particle states, which are energetically incapable of strong hadron emission or else and forbidden by strong and electromagnetic interaction from decaying into lower hadronic states, are characterized by weak interactions. The gravitational force, weakest in strength, determines the behaviour of matter in bulk.

Inspite of the apparent distinction among the various interactions mentioned above, it is an insurmountable task to fit the information available on the properties of elementary particles in any theory adequately. One usually tries to achieve some



al models of elementary particles.

Most of these models incorporate ertain minimum number of particle tates out of which others can be asily constructed. Though these wilding blocks of all elementary particles resemble the observed particles in some respects, are they usually actitious mathematical entities designed to represent the results of a not well understood theory.

One of the earliest suggestions to construct composite models of strongly interacting particles was to consider mesons to be a bound state of a nucleon and an antinucleon. A later suggestion described all mesons as deeply bound states of the triplet; proton, neutron and lambda particles and their corresponding antiparticles. Inspite of some early successes, these models made some wrong predictions and had to be discarded.

The most successful of the composite particle pictures is the "Quark Model" proposed independently by M. Gell-Mann (U.S.A.) and G. Zweig (Switzerland) in 1964. Accord-

ing to this model, all strongly interacting particles, hadrons, are built from a triplet of heavy objects called quarks, and their corresponding antiparticles-a triplet of antiquarks. These three particles are denoted by the symbols u, d and s, and their corresponding antiparticles by a. d. and s, respectively. These particles have fractional charges (a concept introduced for the first time) in terms of the charge of an electron; their charges being 2/3, -1/3, -1/3 of an electron charge respectively. Although experimentally, no fractionally charged particles have been detected so far, there is no compelling theoretical reason to exclude the existence of fractionally charged particles. The spin quantum number of these particles is one-half, while masses are predicted to be quite large-at least a magnitude higher than the nucleon mass. The structure of different strongly interacting particles on the basis of quark model is presented in Table 1. In addition, the quarks are assigned other quantum numbers (some of them fractional) which are necessary for an understanding of the strong interactions.

In the model, the mesons are considered to be bound states of a quark-antiquark pair (qq). The attractive force between q and q could arise, for instance, from the exchange of vector mesons (called gluons). The mesons can also be constructed from more than one (qq) pair, that

is, out of systems of the type (qq), and so on. But there is, in fact no need for such rather involves systems, as all the well established mesonic resonances can be easily accommodated in the known representations of the symmetry grounderlying these particles. It needs to be stressed here that nothing except the simplicity is against these man quark configurations. Table 2 gives the quark contents of some of the mesons along with the masses (expressed in energy units) and other quantum numbers.

The baryon states, on the other hand, are supposed to be three-quar bound states (qqq) having total angular momentum L. The preser (qqq) configuration fits in with all th known resonances but cannot acco mmodate those with positive strange ness (strangeness being anothe quantum number which is conserve in strong and electromagnetic inter actions) in which case more comple configurations such as qqqqq, etc are needed. The quark contents of some of the low lying baryon state are given in Table 3, in addition to some of the other importan quantum numbers.

The quark model requires the hadrons to contain heavy object the masses of the constituents being of an order of magnitude higher that the masses of the hadrons themselve. The constituents then have very high binding energies, which remove we

Table 1. Principat quantum numbers of quark triplet

Quark	JP	Q/c	l ₃	S	В	. Y
u	1 +	+3	+4	0	i	1
d	1.	-4	-1	0	1	i
s	1.	1	0	-1	1	-1

Table 2. Quark contents of posudoscalar and vector mesons

Pseudoscalar Mesons (O-)	Vector Mesons	Quark Contents	Charge	Isospin I	Stran- geness S
π+ (139.6)	p+ (774)	uď	1	1	0
▼° (135)	P° (780)	uū-dd √2	0	1	0
m~ (139.6)	p- (774)	ūd	-1	1	0
κ° (497.7)	κ*° (890)	ds	0	1	1
r+ (493.8)	κ*+ (890)	uš	1	i	1
κ̄° (497.7)	ĸ◆° (890)	ds	0	ł	-1
κ- (493.8)	K*− (890)	űs	-1	1	-1
η (548.6)	ω (783.3)	uu+dd−2ss √6	0	0	0
X° (958.3)	ø (1018.6)	$\frac{u\bar{u}+d\bar{d}+s\bar{s}}{\sqrt{3}}$	0	0	0

(The numbers in parenthesis are the masses of particles in MeV)

over 95% of their rest mass. In principle, there does not seem to be any objection to the existence of such neavy objects. In classical relativistic nechanics, in fact, models exist which have solutions with slow motion and trong binding.

The quark model has been used to lescribe a large variety of phenonena in hadron physics. However, he quark themselves have not been observed experimentally and there is



We have long known that any matter etween us has nothing ultimate in it. low amazing that scientists too have and that there is ultimate in matter"

no satisfactory explanation for their failure to be observed. Many explanations have been given; the most popular being that their mass is too high to be within the range of all experiments performed to date. Analysis of the slow motion strong binding limit mentioned above shows that the observed properties of the bound states are completely independent of the mass of the free quarks. They depend only on an "effective mass" parameter for a bound quark which depends upon the potential as well as the free quark mass. It is, therefore, impossible to estimate the mass of the free quark on the basis of any experiment performed with quarks bound in hadrons.

If quarks exist, they explain the regularities in the observed quantum numbers of the hadron spectrum but they as well pose a new problem: quarks have one-third integral electron charge. The electron is not a hadron. However, the suggestion that

3- Quarks for Mr. Mar

Q Word? However, the particle which has been named so, is reless strange—it is a particle who charge is in fractions, and not in whole numbers as in other particles.

Every word has a history behin it, somebody said, and Quark no exception. The word fir appeared in the famous scholar piece Finnegan's Wake in th sentence: "3 Quarks for M Mark". The piece is from the enigmatic pen of James Joyc (1882-1941), the Irish write famous for his incomprehensib and scholarly writings. The story set against the background of Irish surroundings, is of a famil that Joyce dreamt. In it there one character, Mr. Mark, who ha the habit of moving with thre people on any ocassion and an where. Knowing this behaviour of the character, physicists adopte the word Quark-because Quark are always present together an are three in number, no les no more.

The word 'Quark', otherwise is not sheer gibberish invente by Joyce, but certainly has strange connotation. In German it is a kind of cheese of which a legend says, moon is made How the word inched its way into physics, to become a word of great significance to science, indeed fascinating.

One thing is certain: the physicist who brought in this word is scientific vocabulary must be devotee of Joyce's writings. Joychad said, that to understant Finnegan's Wake a reader had to spend his life-time, let us hop it does not hold true for physicists also who are trying to isolate the Quark.

D.M.S

Table 3. Quark contents of low lying baryon states

Baryon Octet (8)	Baryon Decaplet (10)	Quark Contents	Q	1	s
-	△++(1236)	uuu	+2	1	0
P(938.3)	△+(1236)	uud	+1	1.1	0
N(939.6)	∆°(1236)	udd	0	1.1	0
	△-(1236)	ddd	-1	1	0
X+(1189.5)	X*+(1382)	uus	+1	1	-1
X°(1192.6) ∧°(1115.6)	∑*°(1382)	uds	0	1 0	-1
X-(1197.4)	x*-(1382)	dds	-1	1	-1
三°(1314.7)	±°(1529)	uss	0	ł	-2
<u>=</u> (1321.2)	∃*¯(1529)	dss	-1	ł	-2
	Ω-(1674)	SSS	-1	0	-3

The numbers in parenthesis are the masses of particles in MeV. The charges are given by the formula: $Q = I_a + \gamma_b$, where the hypercharge, $\gamma = B + S$, B being the baryon number.

he basic unit of charge is 1/3, raises he question as to why the electronic harge is three times the basic unit. Any attempt to give a structure to he electron encounters the difficulty of explaining the precise agreement between the experimental value of the electron magnetic moment and the electrodynamics. These predictions are based on the assumption that the electron is an elementary object satisfying Dirac equation, which would not hold true for a composite electron.

In addition to the above Gell-Mann-Zweig quark model, other models with additional quarks have been proposed, primarily for theoretical reasons. These models predict some additional properties of hadrons which have not yet been observed. The additional quarks introduced are of two types; they have been called 'charmed' quarks and 'coloured' quarks. The charmed quarks are simply added to the Gell-Mann-Zweig quarks as the building

blocks to make a total of n quarks, where n is a number introduced to match the predictions with experiments. The number of charmed quarks defines a new conserved quantity, like charge, the angular momentum (called 'charm'). The charmed quarks are assumed to have a mass sufficiently higher than the masses of the conventional triplet.

Coloured quarks, on the other hand, are sets of n triplets giving a total of 3n quarks. The degree of freedom which distinguishes between different triplets has been given the name of 'colour'. One popular model has red, blue and white quark triplets. The coloured excited states are also sometimes called charmed states, but there is a definite physical difference between these two types of non-observed states. The charmed states contain charmed quarks which are different from those in the observed hadron states. The coloured states contain exactly the same coloured quarks as the observed hadrons, they differ only in the sense that they have a different permutation symmetry in the space of colour

Inspite of the remarkable succe of the quark model (almost for decade) in predicting the outcome many particle interactions, exper ments have been reported in which the observations are at variance wit the predictions of the quark mode In one such experiment conducted the Stanford Linear Accelerate Centre (USA), it was found that who high-energy electrons collide with high energy positrons, an unaccoun ably large number of hadrons a produced. The ratio of hadrons mesons, created in these experiment is observed to be much higher tha the corresponding value (2/3) obtain ed within the framework of quamodel. Experimentally, the ratio also found to be energy-dependen again in contradiction with the quamodel which predicts the ratio to independent of energy.

Several attempts have been made to explain this variance between theory and experiment on the basis 'coloured' and 'charmed' quark theories. So, whereas the quark mode has a large number of successes its credit, it has some internal inconsistencies, as well as a few failure too. The search for quarks is ston and if the quarks are found, the discovery will be extremely importating the understanding of the structure of the 'elementary particles'.

Further reading

- Gell Mann, M. Physics letters. 214 (1964).
- Zweig, G. CERN Preprint T 412 (1964).
- Joyce James Finnegan's Walt Viking Press, New York, 193
 - of the fifth Hawati Topi Conference on Particle Physic University Press of Hawa Honolulu, 1974.
 - model (1969), W.A. Benjan Inc., New York.

OPTICS IN COMMUNICATION B.R. MALHOTRA

Development of integrated optics is an attempt to employ film technology in optical circuits and devices. This will have far-reaching impact on the advancement of communication,

information processing and control systems

PHE invention transistor of brought about a revolutionary hange in the field of communication nd information processes. Integated circuits comprising of hundreds f transistors set together and other iniature solid state devices have een designed. Like integrated ircuits in electronics, efforts are now nderway to develop integrated ciruits in optics. Integrated optics is far-reaching endeavour to employ ne film technology to optical circuits nd devices so as to achieve a better nd more comprehensive optical stem. Integrated circuits are laid on nin films which act as miniature nses, lasers, light modulators, risms, etc. By virtue of high freuency of light waves, the amount f information carried by a light gnal will be much greater. Besides, ptical circuits would be much faster nan electronic circuits.

stegrated circuits

With the discovery of laser, which ives out coherent light, fabrication f such circuits became a possiility. Coherent light from the ser can also be modulated or maniulated for practical purposes. To chieve this, bulky optical parts such a prisms, lenses with polished urfaces are required to be mounted in an optical bench. Gas lasers can

be provided on the same bench. But for such a massive assembly huge space is required and such a system cannot be adopted for daily use. The whole arrangement is to be compressed to the size of a coin if the system is to be made suitable for extensive use.

Though the concept of integrated circuits was known much earlier, the actual research efforts started only in 1960s by various workers in Bell Laboratories, California Institute of Technology; International Business Machine. Corp. etc. First, the successful development of fibre glass, which can conduct light with negligible loss, was a vital landmark. Fibre glass consists of very fine glass fibres, usually one thousandth of a centimetre in diameter, but possesses a high tensile strength. Second factor happens to be the availability of cheap, durable solid state light sources, like laser, which can emit intense, coherent light waves. These two developments largely paved the way for emergence of optical communication system. Third, the technique of marking and etching complex circuits on surfaces by electron bram has progressed so much so that it is now possible to compress circuit to a thousandth part of a centimeter Fourth, the circumstances which gave a compulsive drive to the development of miniature circuits were in the demand of modern science and technology.

In the early stage of the develop ment of integrated optical circuit various difficulties were faced with The difficulties related to the materia to be used for thin films and their fabrication, propagation of light through thin films, etc. The problem relating to putting the beam and taking it out when desired was the most formidable one. Since mos of the films used earlier had extremely small thickness of the order of 10-4 m, it was difficult to focus the laser beam on the edge of the film. Soon it was discovered that the light wave could be made to enter the film if a prism is coupled to it near the edge. A similar prism coupler is used to extract the beam from the

r. Malhotra is a scientist at Central Road Research Institute. New Delhi.

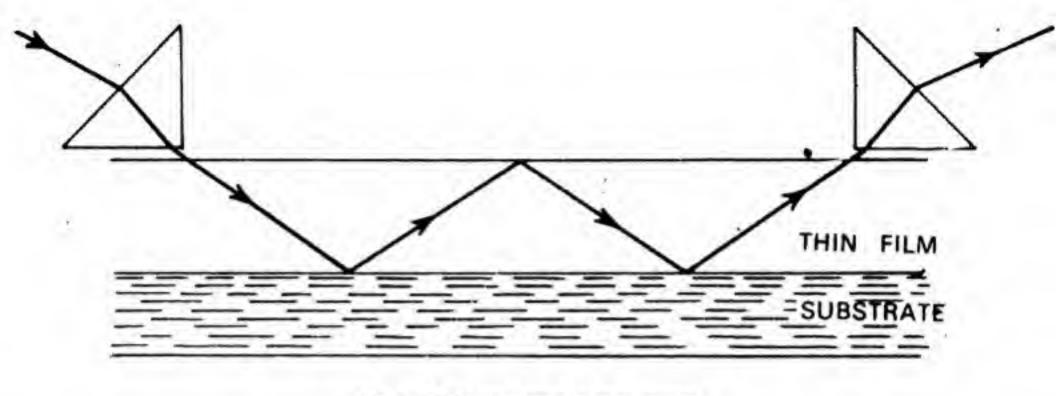


Fig. 1. Light taken out by a prism coupler

ilm. The development of integrated optical circuits was much hastned by he invention of prism coupler and grating coupler. These are optical levices to deflect a light wave to a known path and disperse it into constituent wavelengths. This was ollowed by the development of a nost of thin film devices which incluled thin film lenses, mirrors and polarizers. Polarizers are used to imit the transverse vibrations of a ight wave to one plane. The other set corresponded to thin film lasers and light switches. The efforts to make workable and lasting optical circuit started only recently.

The principle underlying the propagation of light in a thin film is quite instructive. The thin film which has generally one micron thickness is supported on a thicker substrate of glass. The function of thin film is to act as a waveguide which becomes possible only if its refractive index is higher than the surrounding medium. A combination of such optical devices on a common base, and inter-connected with one another, constitutes an optical integrated circuit. A light wave on entering the thin film gets totally reflected internally, both at the upper and lower surfaces as shown in Fig. 1. This happens for two reasons:

(i) refractive index of thin film is more than that of the air because thin film is a medium denser than air.

(ii) angle of incidence, i.e., angle between the ray of light and the normal is more than a critical value. As a consequence of these bounces the light wave follows a zig-zag path. This concept of zig-zag path is vital in understanding the behaviour of light wave in a thin film and also the mechanism as to how light wave carries a lot of information. A zigzag wave is identified by the angle between two tracks of its path. Light waves with different zig-zag paths are independent of each other. The number of waveguides traversing a thin film depends upon the wave length of laser light, the material of the film and its refractive index, thickness and nature of the substrate. Since each wave serves as a carrier of one channel of information, a thin film can serve as a wave guide for many channels in a communication system. To have a channel of one's choice, laser beam must enter the prism coupler at a particular angle. By controlling the angle of incidence of the entering beam, it is possible to excite wave guide of any mode.

Loss of light

In integrated optics, loss of light by scattering poses the most perplexing problem to the researchers. A light wave experiences reflections about 1000 times on film of one micron thickness while traversing a distance of one centimeter. In case the thin film surface is not perfectly smooth, a fraction of light would b scattered. Even with an insignifican amount of scattering, the light wav will not propagate much. To achiev an appreciable traverse of light wave experiments have shown that loss o each reflection must be one part i 10,000 which happens to be on tenth of the loss in good qualit mirrors. Another serious probler relates to tiny irregularities an deformities on the surface. How t perfect the technique of making thi films free from minute pin-holes an other faults of surface unevenner remains the major concern of th investigators. Another point of vita consideration is that the velocity of light waves is higher in thinner film than in thicker films. So, when thin film is to be joined to a thic film, lens or a prism it should b tapered and then connected.

A successful intergated optical system involves many technical intricacties. One of these relates to the construction of thin prisms and lenses. A prism can be made by depositing uniform film material on the substrate and then joining another layer through a mask with a triangular opening. As the prism is thicker than this film, light waves travel slower and generacted on entering it. So prisms an lenses can be built in the same way Another point worth notice is that the light wave can be reflected not only on the top or bottom surface.

of a thin film but also in the middle. The fabrication of a thin film mirror ouzzled the research workers in the beginning because any metallic mirror would absorb more than it would reflect. This was accomplished by etching a grating with a beam of ions. The thin film mirror is made by etching a grating on the substrate and hen covering both the substrate and grating with a thin film. A grating of). 1mm width with 500 grooves can reflect all the light incident on it. Considering such thin film mirrors placed at two ends of a thin film wave guide, a light wave impinging on one mirror will be reflected back o the other mirror where it will experience reflection back to the first one. By virtue of repeated reflections he light is trapped between these two nirrors which behave as an optical avity. If the film is made of some aser material to amplify light, the ight wave would be intensely built ip and the cavity would serve as source of continuous, sustained adiation like a laser.

Materials for lasers

Thin film lasers made from polyrethane film with dye cannot be ised in integrated circuits as it has een found that dye bleaches out fter a short interval. So thin film asers emitting infra-red radiations re best suited as glass fibres used for ransmitting laser radiations and lose ninimum light by scattering or by bsorption. Such a laser can be nade from neodymium which geneates light of 1 micron wave length. nother advantage associated with he use of neodymium laser is that it an be pumped by light emitting olid state diode, so the whole arranement can be a solid state assembly. nother alternative source giving out missions at 0.85 micron is an injecion laser made up of aluminium, allium and arsenic. This device has he advantage in a way that it conerts electric energy directly into adiation. The need for a separate

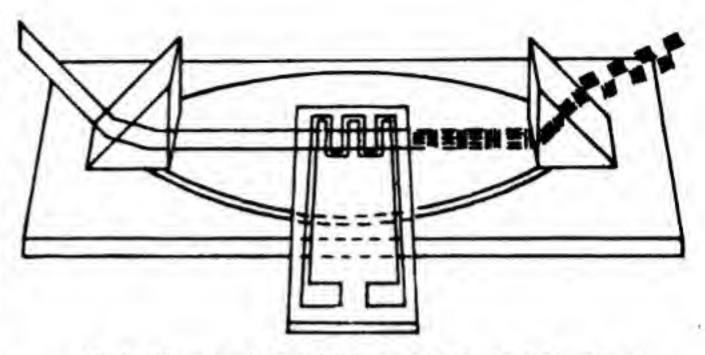


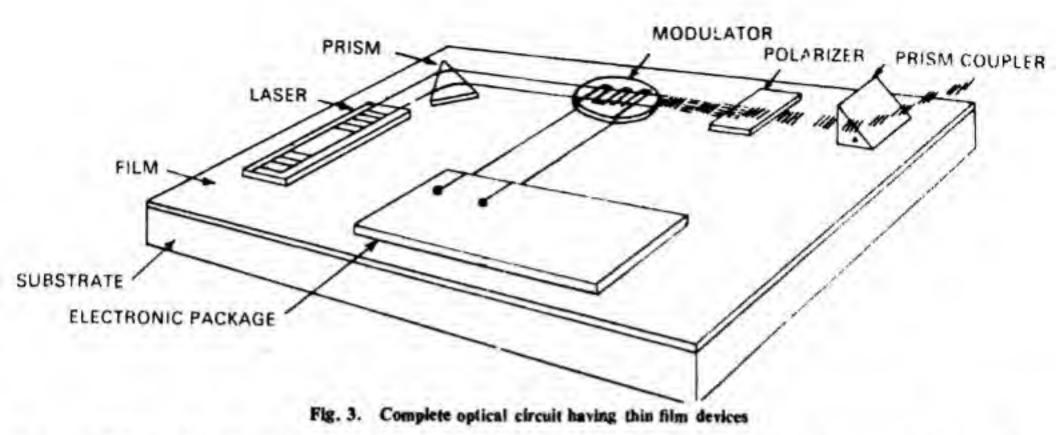
Fig. 2. Magneto-optical switch to impose voice signal on the laser beam

light source is thus dispensed with. But the gallium-arsenic laser suffers from the limitation of having a high refractive index as compared to that of materials used for other thin film parts. The second limitation associated with injection laser is that grating structure cannot be fabricated in it. This short-coming is obviated by making possible the use of a thin film corner reflector. Such a corner reflector is mainly a thin film right angle prism, the light wave enters through its hypotenuse and emerges from the same face after being reflected at two right angle faces. For a successful integrated optical circuit, another important component called the modulator is being developed. Before the laser light carries information over to a communication system, it has to be modulated through a thin film switch. Among the numerous modulators available the one magneto-optical switch is thought to be quite suitable. This modulator can work with a frequency of 3×108 times per second and this happens to be three times faster than the latest transistorized communication coaxial cable in use at the moment. The switch (Fig. 2) comprises of a film of magnetic irongarnet on a substrate of garnet. There is an infrared output of a helium-neon laser, coupled into the film, and a closely contacted looped electric circuit. In this magnetic

film, there exists a large number of unpaired electron spins. On apply ing a magnetic field, these unpaired electrons align themselves along the magnetic field and the film is magne tised. The magnetic moment, both in magnitude and direction, can be represented by a magnetization vec tor. The magnetization potentia can be in the plane of the film but a right angle to the direction of propa gation of light wave, in the absence of any externally applied field. Or passing current to the electric circuit a magnetic field is produced which rotates the magnetization vector in the direction of propagation of light wave. So the magnetic vector lies



"Optics are a great help in the communication of delicate emotions too"



either parallel to the direction of ight wave or perpendicular, dependng on when electric switch is on or off. The effect of different directions of magnetization vector is that light wave is polarized first in one direction and then in perpendicular direction. n an actual integrated ircuit, the light wave modulated by he electric switch could travel to a hin film polarizer, made simply of thin strip deposited on thin film wave guide. The light wave would either be transmitted or absorbed depending on the direction of polariration of the light wave. This can be put oft and on as per the operation of electric circuit.

Types of thin film

There are two types of thin film which possess different properties. They are made by two separate techniques, one type is used for forming active devices like lasers and modulators, while the other type is suited for passive devices like prisms and enses. The one used for active devices is a single crystal film consisting of regular array of atoms. It is made by taking a substrate having a certain lattice structure and immersing it in a container with a solution of the film material. The film grows layer by layer of atoms in a lattice structure matching with atom lattice of the substrate. The material of the film may be same or different

from that of the substrate. The second type used for passive devices is amorphous in character and has no crystal lattice structure. This can be deposited either by evaporation method or by sputtering. In the first method, the film material is heated and the vapours are made to condense on a cooler substrate to make a thin film. Also, this type of film can be made by sputtering the material onto a substrate in a vacuum chamber. By accelerating ions and electrons to high velocity and making them impinge on the film materials, they knock atoms out of it. The atoms settle there and build up a thin layer of film material on the substrate. Complete integrated circuit, as depicted in Fig. 3, can be made by making individual units sepatately and then connecting them. To have a conducting connection, the two film devices of different thicknesses and refractive indices are first tapered and then a rhird film is deposited between them. Thin film is in direct contact with these two devices and the substrate, and its two ends are tapered to provide a smooth path for the light travelling from one device to another.

Development of integrated optical circuits is still in the experimental stage and their use on a commercial level depends much on the availability of materials to make thin films. Modulators and lasers are to be made

from single crystal films and the material used for the film should be different from that of the substrate To grow such a film with two solid phases, the material of the film should match closely with that of the substrate, otherwise polishing would be necessary to make the film smooth. As a sequel to the research work done in this direction, two unique systems of materials have been found suitable for thin films. One i aluminium-gallium-arsenic system the lattice structure of aluminium arsenide is in tune with gallium arsenide at a temperature of 900 C The other system consists of garnets the lattice of which can be changed by adding different ions of rare eart elements. It is possible to choos one garnet for the substrate an another matching for the film Studies have shown that garnet film are the best available at the moment.

Till the technique of making mono lithic integrated optical circuits of perfected, circuits comprising device of different materials would alone be available. Though much research effort has been invested in developing integrated optical circuits, the actual utilization in practice has yet to come. This development may be the next major landmark in the fields of physics, material science are electronics.

(Continued on page 21

Change in entropy plays a vital role in deciding what way a chemical reaction will go



the spirit of Chemical Science

TITHAT are chemical reactions? Many chemical reactions have occurred in your brain in the short ime you asked this It is impossible to estimate the number of chemical reactions that take place in the world in the course of a second. The great diversity of chemical compounds, play vital roles in our day-to-day ife and without which there would have been no life, owes its existance o processes called chemical reactions. Every act and feeling of us is backed by millions of chemical reactions, which, of course, we are not able to see. However, there are as many eactions taking place before our yes.

You strike a match, and a stick of wood bursts into flame and turns nto charcoal. This is a chemical eaction. Similarly, as you look it a green leaf, you can be sure that t is making sugar molecules by photosynthesis and stores them in the eaves until you cook them and eat or some animal eats them and you, n turn, cat the animal. We write he reaction in this manner.

CO, + 6 HO, Sunlight from rom ground Chlorophyll air

C,H,O, + 6 CO, goes into air Sugar

The energy used by your body when you move your eye across this page and think about it is released within your body, by oxidiation sugar of in the respiration reaction.

go out

So, our body needs fuel (food) to function as an automobile engine needs fuel to move. A mixture of gasoline (which contains compounds of carbon and hydrogen) and air explodes in the cylinders of an automobile, releasing energy that moves the automobile according to the reaction:

It is interesting to see that the body's food-into-energy reaction is similar to the automobile's fuelinto-energy reaction, both using the oxygen of the air and releasing energy.

Another interesting example of chemical reaction is provided by th formation of common salt (sodius chloride) from sodium metal an chorine gas. A sodium wire burns i chlorine gas to form salt. Wha surprised the early chemists is that the salt obtained has propertie quite different from those of th reacting sodium and chlorine. Sodius is a soft, silvery metal and chlorine a corrosive gas which irritates th mucous membrane of the nos and throat if inhaled. But, salt, a we all know, is quite different an finds place in most of our foo preparations. A chemical reaction transforms reactants (sodiur and chlorine) into products (salt and the products have propertie quite different from those of th reactants.

What happens during a chemica reaction?

.. During a chemical reaction ther occurs a rearrangement of atoms The reaction of sodium and chlorin to form sodium chloride serves a an example. The metal sodium consists of sodium atoms arranged i a regular structure. The gas chlorin consists of molecules. During th

or. Sastri is Development Chemist at Greaves Foseco Ltd., Pune 411019

eaction of sodium and chlorine, he sodium atoms in the metal eparate from one another and kewise the two chlorine atoms in he chlorine molecule separate rom each other. The atoms of odium and chlorine then arrange hemselves in a new structure in which the atoms of the two kinds lternate. This arrangement of odium and chlorine atoms constitutes the new substance, sodium hloride, that has formed during the chemical reaction.

Vhy do chemical reactions proceed?

The question—why do chemical eactions take place—is one of the nost fundamental questions asked by chemistry students. One very often ets the doubt as to why certain pairs of reactants do not give any products while a chemical change occurs in ther cases. This problem is very nuch complicated and scientists have hought over it seriously.

low and fast reactions

A chemical reaction may take place instantaneously or it may take a ong time, even years in some ases. An explosion is a terrible thing hat occurs instantly. Combustion of gun powder in a bullet shell or the explosion of dynamite are examples of ordinary chemical processes which ake place in a split second and are accompanied by the evolution of large amount of gases.

But an explosion is an extreme ase. Most of the chemical reactions ake some time and there are many themical reactions which take place to slowly that they can hardly be detected and one is often misled that no reaction has taken place at all, magine a mixture of two gases, hydrogen and oxygen, at room emperature in a glass container. They can remain in it for a hundred tears without the formation of a single drop of water, making one believe that hydrogen is not reacting with oxygen. But, in fact it is, althorized the sygen. But, in fact it is, althorized the sygen.

ugh very slowly. To test it, if you heat the container, you notice formation of drops of moisture on the surface of the glass. At 550°C, the reaction is so vigorous that the container flies apart in tiny fragments. This is an example of heat-accelerated chemical process.

Activation energy-the magic barrier

Why does heat accelerate the formation of water from hydrogen and oxygen? Hydrogen exists as H, molecules and oxygen as Oz molecules in their free state. However, before they can react to form water they must break up into atoms. Here comes the role of temperature. It makes the hydrogen and oxygen meet at the atomic level that they react instantly. SO All molecules cannot enter into chemical reactions unless their energy equals or exceeds a certain energy. The reason why at room temperature the formation of water from H, and O, is very slow is that at room temperature the number of sufficiently energetic molecules is exceedingly small. At high temperatures many molecules attain their activation energy making the reaction go faster.

This magic barrier, also known as activation energy, stands in the way of a "universal catastrophe" (wherein every substance coming in contact with any other substance would react instantaneously irrespective of the energy it possesses) threatening us. Had there been no such barrier, all the substances would have been converted into the most stable substances in breathtaking time, making the world strange and lifeless. For example, all the atmospheric hydrogen and oxygen would have been converted into water, all the metals into their powdery oxides, and complex organic substances into simple and stable compounds. Fortunately this barrier of activation energy comes to the rescue of the world and life in it.

There are ways of measuring the

rates of chemical reactions. This is the field of reaction kineties. But having measured the rates, we are not nearer to the answer of our main question as to why certain reactants have got the ability to react and form products. The reactions having the potential to occur without the assistance of external agency (irrespective of whether they are fast or slow) are called spontaneous reactions. Now let us examine the reasons of spontaneity of chemical processes.

Factors favouring a chemical change

If we were able to see what happen to the individual atoms of the reac tants while a reaction is proceeding our task would have been easier However, this is not possible. Bu we can infer as to what migh be happening from experimenta measurements carried out on the reactants and products. An easie way is to examine the natur of simple examples of spontaneit and try to apply them to chemica reactions. We know that water flows down the hill. This is spontaneous process as it does no require any external agency. Simi larly a stone falling from a height, stretched piece of elastic contracting on release are examples of such processes. However the revers processes are not spontaneous a they need application of an externa agency. Water cannot of its own accord go up (it has to be pumped and a stone cannot rise by itself.

If one follows carefully what is happening in all the above spontaneous processes, one easily comes to know that a common feature of all of them is a net lowering of potential energy in the direction of spontaneous change. A chemical reaction is also likely to be spontaneous in the direction where a decrease in potential energy takes placed thowever, this decrease in energy manifests in some form, presumable as heat. Thus, Thomsen (Danis)

hemist) and Berthelot (French) in 878 suggested that the change in nergy as measured by heat evolved a chemical reaction was the driving orce behind a chemical reaction. There are many exothermic reactions those in which heat is evolved) in upport of this view. For example (graphite) + O₂ (g)

 $C (graphite) + O_s (g)$ = $CO_s (g) + 393.3 \text{ KJ}$

r conventionally, the heat content of the reaction,

$$\Delta H = -393.3 \text{ KJ}$$

 $nd \ 2H_{a}(a) + O_{a}(a) = 2H_{a}O(a)$
 $\Delta H = -569.0 \text{ KJ}$

However this postulate is not alays, applicable since there are many hemical reactions which are accomanied by an absorption of heat from no surroundings. Such reactions re called endothermic reactions there ΔH becomes positive since eat is gained by the system. Some uch examples are:

 $H_{\bullet}(graphite) + H_{\bullet}O(g) = CO(g) + H_{\bullet}(g)$ H = +121.3 KJ, and

 $I_{g(g)}+I_{g(g)}=2HI(g), \triangle H=+53.6 \text{ KJ}$

The occurrence of such endothernic reactions suggests that a decrease a energy is not entirely responsible or the driving force of a chemical eaction while it is true that it favours chemical reaction to proceed.

Now we have to see what other actors might be responsible. So far, e have discussed the natural sponaneous processes (a falling stone, for xample) wherein a decrease in potenal energy takes place. We can have dea of the driving force of an endohermic reaction if we study natural pontaneous processes wherein there no change in total energy during he reaction. Such systems wherein otal energy remains constant are alled isolated systems. The diffuon of two gases into each other is a pontaneous process and, if carried ut in a closed container, becomes an colated system. Suppose that two ases at the same temperature and ressure are present in two compartents and are separated by a movable

partition. On withdrawing the partition, the gases diffuse into each other, the system becoming more mixed up, i.e., the probability of a chosen molecule of either gas occupying a given volume of space has decreased during the change. In another way, the system has become less predictable or more chaotic.

Another example is the expansion of an ideal gas into vacuum. This is spontaneous and is irreversible, i.e., a gas will not contract in volume of its own accord. In this case also, the change is accompanied by an increase in the degree of disorder (or entropy) of the system.

One may now conclude that for a spontaneous process in an isolated system, the system tends to become more disordered or its entropy increases. The entropy of a system is high if it is more disordered and for a very orderly system it is low. Entropy is given the symbol 'S' and for a spontaneous change in an

isolated system, \(\triangle S \) must be positi

How does changes in entropy co about?

As we have already seen, a cher cal reaction is simply a rearrangem of atoms or ions from one pattern the reactants to another in the p ducts. In chemical reactions, entro change occur because of this diff ence in the arrangement. If structure of the products is very mu more disordered than that of reactants, there will be a resulta increase in entropy and vice ver If in a chemical reaction the are changes in both energy a entropy, neither a decrease in he energy nor an increase in entro can alone determine the direction spontaneous change. The results of both these effects would deci whether a reaction would procee and if so, in what direction.

Dissolution of ammonium nitra in water is accompanied by bo



"Taking the cue, I am infusing spirit into the chemical reaction"

an endothermic reaction and $\triangle H$ large and positive. However, nee the NH₄+ and NO₃⁻ ions are aving their positions on the crystal tice and are adopting a more irrelar disposition in solution, the rocess is accompanied by an crease in entropy. $\triangle S$ is quite rege and positive. Here the energy and entropy changes oppose each ther in their influence on the director of spontaneous change. Entropy nange, being the dominant one, evours the dissolution.

Because of this opposing effect, a sw function is defined incorporating oth of these. The symbol is $\triangle G$, is defined in terms of change in stal energy $\triangle H$ and change in stropy $\triangle S$ and the absolute temperature at which the reaction takes lace.

 $\triangle G = \triangle H - T \triangle S$ $\triangle G$ is known as the change in ee energy of the reaction. From its relation, if $\triangle H$ is negative and $\triangle S$ positive, then since (absolute temp.) is always positive, $\triangle G$ would be negative. In general, nany chemical reactions correspond to the closed system where oth energy and entropy changes the place at constant temperals.

rature and pressure. The criterion for a spontaneous change in such systems is that $\triangle G$ must be negative. This relation allows us to predict in advance whether a proposed chemical reaction will take place or not, provided we know enough about energy and entropy changes. If the reaction is exothermic and is accompanied by an increase in entropy. △G is negative and the reaction proceeds, while an endothermic reaction accompanied by a decrease in entropy would not proceed at all. When the two effects oppose each other, only those reactions proceed which have a negative AG.

An endothermic reaction for which $\triangle S$ is positive and $\triangle G$ is also positive at room temperature (and hence should not proceed at room temperature) may proceed at high temperature only, as can be seen from the above relation. Therefore, the temperature has got a marked effect on the occurrence of chemical reactions. Similarly exothermic reactions accompanied by a decrease in entropy have a higher chance of proceeding at lower temperatures. So chemical reactions once thought to be never proceeding were made to proceed under suitable conditions by either a decrease or increase in the

temperature.

Conclusion

Chemical reactions are the spir of chemical science and they make the principal subject matter o chemistry. A world without chem cal reactions would be a strange an fantastic one. It would be a life less world of very stable compound with no inclination to react. Forti nately this is not the case. Man curiosity about his environment ha helped him prepare all kinds of sub stances by means of chemical read tions from the simple water mole cules to infinitely complex protein Chemical reactions feed us, shelte us and protect us from suffering They can make the world a happing place for the people to live in, b raising standards or living. Chem cal reactions play such an importar part in the life of the twentiet century man that this age ma properly be called the chemical ag

Further reading

- Thompson, J.J., An introduction to chemical energetics, Longman Green & Co Ltd., (1969)
- 2. MacWood, G.E. and Verhood F.H., Journal of Chemical Education, 38 (1961), p 334.

CHANGE OF ADDRESS

- Subscribers are advised to inform us in regard to change of address six weeks in advance. During this period, please arrange to collect your copies at your old address.
- While asking for change of address please write your SUBSCRIPTION NUMBER, in the absence of which change of address may not be effected.

FERREDOXIN is relatively new to biochemistry. Its discovery dates back to the late 1950s when workers in photosynthesis noted that the reduction of nicotinamide adenine dinucleotide phosphate (NADP) and the evolution of oxygen by isolated chloroplasts required the presence of a 'protein factor'. In 1958 A. San Pietro and H.M. Lang of the Charles F. Kettering Research Laboratory, Yellow Springs, Ohio, U.S.A. exracted and partially purified the protein factor' from the chloroplasts giving it the name photosynthetic yridine nucleotide reductase PPNR). During their studies on itrogen fixation in cell-free extracts f Clostridium pasteurianum, L.E. Mortenson, R.C. Valentine and J.E. Carnahan of the E.I. due Pont Central Research Department, Delaware, U.S.A. (1962) noted the equirement of an 'iron-redox protein' for the electron carrier. 'hey called it 'Ferredoxin'. The urified protein from spinach was iter called 'Ferredoxin' by D.I. rnon and his coworkers at the Iniversity of California, Berkeley, alifornia, U.S.A. in 1962 because had properties identical to those of rredoxin from nitrogen-fixing bacria. What we now call ferredoxin as been variously called as ethaemoglobin-reducing factor. ADP-reducing factor, PPNR. nem-reducing factor red zyme. Ferredoxins have been olated from non-photosynthetic naerobic bacteria, photosynthetic acteria, algae, leaf tissues of higher ants and from animals.

aming and properties

According to the January 1973 commendation of IUPAC-IUB ommission on Biochemical Nomenaure, ferredoxin is used as a generic rm for those metalloproteins known iron-sulfur proteins which have ual numbers of iron and labile lfur atoms. The sulfur atom is acid-bile and yields hydrogen sulfide

One of the first proteins to emerge from the 'primeval soup was ferredoxin. Besides playing a major role as a biological reducing agent, the protein can be of immense help in tracing the course of evolution



MANORANJAN KAR DINABANDHU MISHRA PRASANNA KUMAR PRADHAN

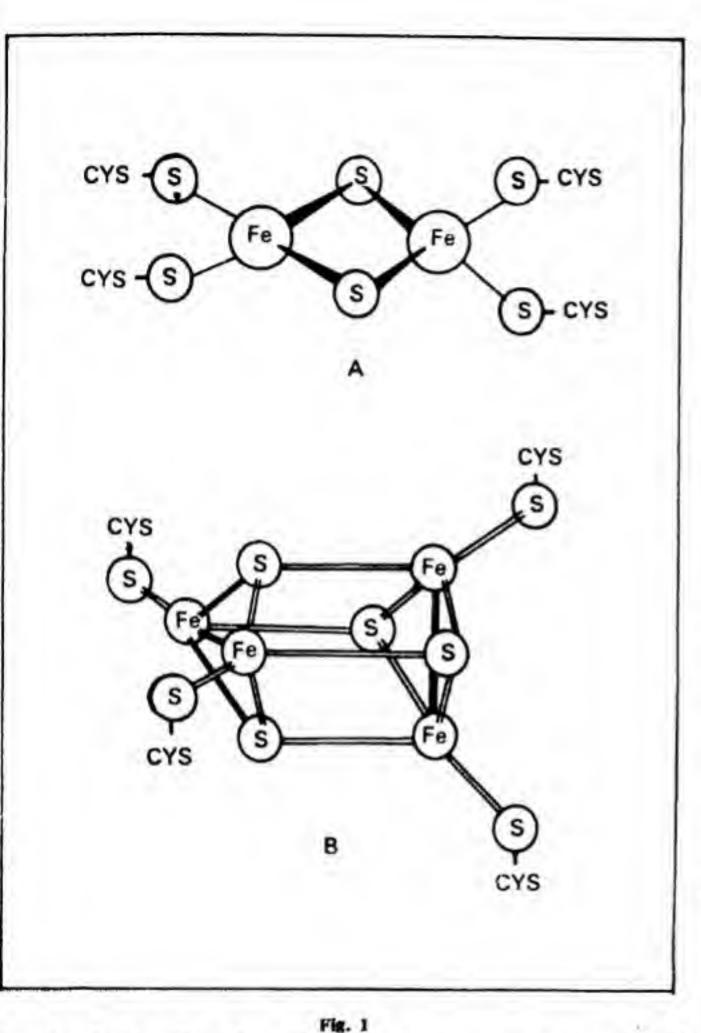
on acidification. The chemical nature of the acid-labile sulfur is uncertain, although there is some evidence that it arises from sources other than the cysteine residues of the polypeptide. The ferredoxins have a negative midpoint redox potential at pH 7. They are characterized by an electronparamagnetic resonance (EPR) signal at g > 2 for the reduced protein. Ferredoxins are present in plants, animals and bacteria. For naming, the source should always be stated, for example, chloroplast ferredoxin, adrenal ferredoxin, Pseudomonas putila ferredoxin, Clostridium acidi-urici ferredoxin, etc. Ferredoxins have molecular weights of 6,000 to 12,000 -the lower molecular weights characterise bacterial ferredoxins, and the higher are those isolated from chloroplasts of higher plants. The isolated plant and algal ferredoxins are red in colour with absorption maxima at 277, 330, and 420 nm in the oxidized form. Reduced ferre-

doxins are strongly autoxidizable Ferredoxin may be abbreviated Fd.

Structure

The ferredoxin molecule is small and in addition to only 50 to 100 amino acids contains iron and sulphus atoms. It is now well established tha ferredoxin contains 2, 4, 6, or 8 iron atoms together with an equal number of labile sulphur atoms and a considerable number of cysteine amino acid residues. Evidence concerning how they link together is still lacking inspite of many propositions advanced from time to time. Taking into account the evidences available some model systems can be constructed. Recent evidence indicates that ferredoxins contain iron in tetrahedral sites. The equal number of iron and sulfur atoms suggests highly ordered structures for ferredoxins. With these and some other evidences on hand, the most favoured structure for the 2Fe+2S ferredoxin is shown in

Mishra is Reader in Botany at Utkal University; Shri Pradhan is I.F.S. Probationer at Indian Forest College, Dehra Dun; Shri Kar



ig. 1(a). For the 4Fe+4S proteins, he arrangement is the pseudo-cubane ructure as shown in Fig. 1(b). This

structure gives a resultant pseudotetrahedral environment to the iron atoms. Few systems are available as models for the 6Fe+6S and 8Fe+18 proteins. Sophisticated X-ray studi of an 8Fe+8S protein show two clusters of very high electron densi of cubic shape. The model for the protein has been suggested to consi of two pseudo-cubane units seprated by 12 A.

Functions

Basically ferredoxins are biologic reducing agents. They transfer eletrons at very low redox potential. As such, they act as electron carrie in such diverse biochemical process as photosynthesis, carbon metablism and nitrogen fixation.

Photosynthesis. Because of its r markably negative redox potentia D.I. Arnon (1967) suggested th ferredoxin is the immediate electro acceptor from Photosystem I. Hov ever, in 1959 A San Pietro of the Charles F. Kettering Research Lab ratory, Yellow Springs, Ohio, U.S.A and A. Trebst of the Department Plant Physiology, University Gottingen. Germany in indepe have dent studies shown th a substance of unknown chemic composition, 'ferredoxin reducir substance' (FRS) which is mo electronegative than ferredoxin ma be located between Photosyste I and ferredoxin. Ferredoxin reduced by the electron flowing from illuminated Photosystem I. Ti reduced ferredoxin, in turn, causes the reduction of nicotinamide adenii dinucleotide phosphate (NADP) in reaction catalysed by the enzyn reductase. Th ferredoxin-NADP

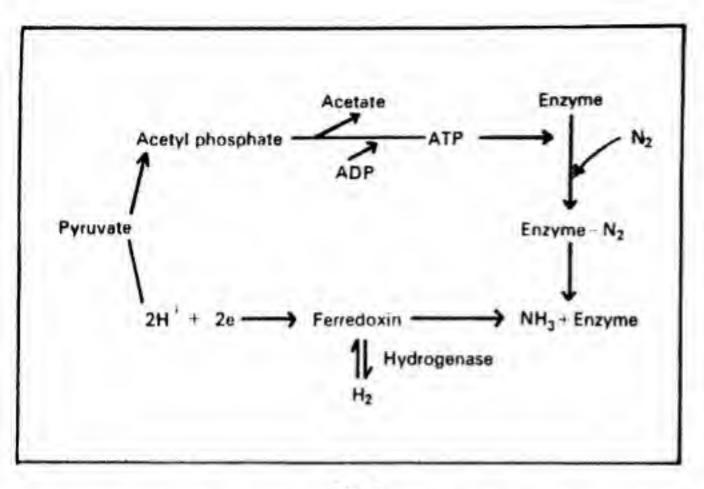


Fig. 3

inzymatic reaction is independent of ight. The role of ferredoxin in the photosynthetic reduction of NADP is outlined in Fig. 2.

Carbon dioxide fixation. In bacterial systems, fixation of carbon dioxide is apparently a ferredoxin-dependent eversal of the reactions of the tri-arboxylic acid cycle or the Krebs cycle. The strong reducing potential of ferredoxin drives the reversals of the two reactions of the tricarboxylic acid cycle, which otherwise are reversible in aerobic cells. These we carboxylating reactions are:

Acetyl-CoA + CO_a + Fd (reduced) \rightarrow Pyruvate + CoA + Fd \rightarrow (oxidised)

Succinyl-CoA+CO₁+Fd(reduced) +o(-Ketoglutarate+CoA+Fd (oxidised)

These reactions are reversible in shlorobium because this bacterium is able to generate reduced ferredoxin photosynthetically and to use its strong reducing power to overcome the large energy barrier of these carboxylations. Ferredoxin is one of the most electronegative electron carriers and it has the potential to drive the earboxylation of acetyl-CoA and succinyl-CoA.

Nitrogen fixation. Pyruvate seems o play a role in nitrogen fixation and

ferredoxin acts as an intermediate in the transport of electrons from phosphoroelastic decomposition of pyruvate to nitrogen fixation in Clostridium pasteurianum. Molecular hydrogen can also act as a source of electrons for nitrogen fixation in C. pasteurianum provided adenosine triphosphate (ATP) or acetylphosphate is present, but in this case also ferredoxin is required for nitrogen fixation. The role of ferredoxin in nitrogen fixation. The role of ferredoxin in nitrogen fixation in bacterial systems is shown in Fig. 3.

Ferredoxin an evolutionary indicator

Besides acting as a biological reducing agent, ferredoxins can be more useful in tracing the evolutionary pathway that the living organisms have undergone with the passage of time. They were probably the first proteins to emerge from the 'primeval soup' and had played an important role in the origin of life. It becomes more clear by considering the simplicity of their biosynthesis. Once the protein is synthesised the iron and sulphur atom can readily combine with it in a non-enzymatic reaction to form ferredoxin. In fact, this simplicity is suggestive of them as being made by the first forms of life. Moreover, four species of bacteria belonging to the genera Clostridium

and Micrococcus have ferredox containing only fourteen different amino acids with nine of these co mon to all of them. And these ni amino acids are identical to the that are readily synthesised abioger cally in laboratory experimen under conditions simulating that the primeval earth. Still more, in t Murchison meteorite that fell Australia in 1969, are found, amount other substances, six amino aci that are identical to six of the ni amino acids in bacterial ferredoxi stated above. The absence of amin acids like methionine, histidine ar tryptophan that are difficult to I synthesised abiogenically under lab ratory conditions from these ferred xins can also be taken as an indire evidence. All these facts, when take together, are sufficiently significant t bring out the conclusion that ferredo xins were the first proteins to b formed and utilized by the first form of life that appeared on the eart billions of years ago.

It seems probable that the earl fermenting bacteria (which are considered as the first living organism to appear on the earth more than 320 million years ago) were using their for electron transfer during the fermenting process. Ferredoxins from the present day fermenting bacterialise Micrococcus and Clostridium and also relatively simple and have two very similar blocks of 26 amino acid joined end-to-end, each containing

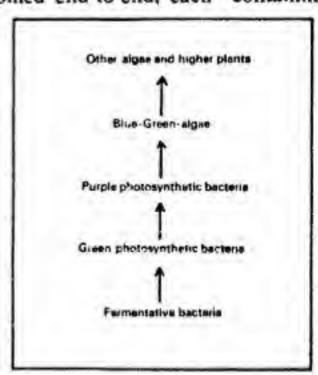


Fig. 4

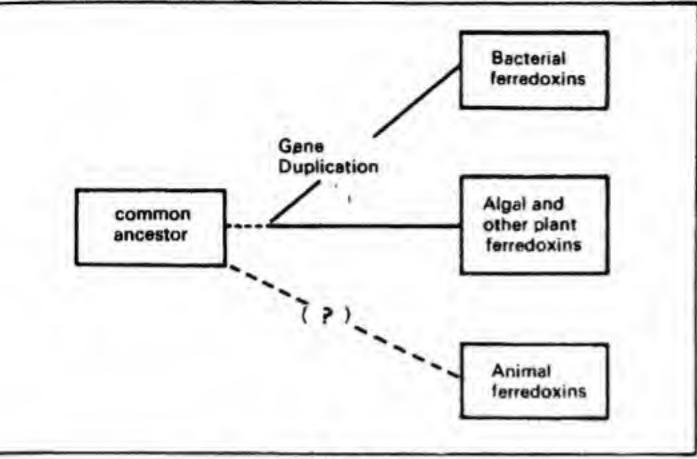


Fig. 5

our vital cysteine groups. It appears not the first organisms probably onsisted of only one of these blocks 26 amino acids with four cysteine roups. Later, during evolution, the ze doubled by gene duplication are by giving rise to the ancestors the present bacterial ferredoxins ith 8 cysteine groups.

Green photosynthetic bacteria that arvest energy from the sun for their fe processes were probably the next appear on the evolutionary scene. hese bacteria carry out a simple type f photosynthesis with ferredoxins aving the protein parts containing amino acids.

The purple photosynthetic bacteria ppear later in the evolution. These re structurally more sophisticated can the green photosynthetic bacteria with more complex metabolism. The protein part of these bacterial erredoxins consists of 81 amino cids.

The blue-green-algae are more exent than the bacteria. With their dvanced type of photosynthetic stems, they changed the anaerobic ondition of the primitive earth to aerobic condition. The ferredoins of the blue-green-algae are different from those of the bacteria having longer protein chain of 97 amino cids, and containing only two atoms

each of iron and sulphur. In all physical properties and structural and functional aspects these blue-green-algae ferredoxins resemble the ferredoxins from other algae and higher plants, inspite of the existence of a fundamental difference between themselves. The former ferredoxins are procaryotic and the latter eucaryotic. This similarity in ferredoxin structure as well as function is in fact very much significant if we accept the suggestion that chloroplasts were first formed from the blue-green-algae which came to live symbiotically inside the early plant cells. All chloroplast ferredoxins would be derived from a common ancestor, namely, the blue-green-algae.

Considering the structure of the types of ferredoxin described one can trace the evolutionary pathway from the simplest organisms to higher plants in the sequence given in Fig. 4. However, there is a big gap between plant-type ferredoxins and bacterial ferredoxins. So far no intermediate form has been found. Using a few biochemical processes planttype-ferredoxins can be made to function, though with less efficiency in bacterial systems and vice versa. This and their structural differences seem to suggest that the plant and bacterial ferredoxins diverged from

a common ancestor containing pr bably four cysteine groups (Fig. : The bacterial ferredoxin might ha developed from the common ancest by gene duplication and produced protein with 8 cysteine groups. (the other hand ferredoxins from blu green-algae, other algae and high plants appear to have developed fro the same ancestor by increasing t length of the protein chain. It is also significant coincidence that comple ity of photosynthetic apparatus at length of the ferredoxin protein cha proceed side by side. Possibly, the ferredoxins have long protein chai so that they will fit into the membra system of the photosynthetic app ratus.

Animal ferredoxins appear to confrom a third line of evolution. The amino acid sequence of only or animal ferredoxin, the bovine adrent ferredoxin, is known. This ferredox is not like others described above even though its active centre seer similar.

Ferredoxins are a class of prote in which the pattern of evolution conhe seen by properly interpreting to information contained in them. Of knowledge about ferredoxins is in creasing. We will soon be able trace the complete evolutionary pat way with all its twists and turns from the beginning to the present day.

Further reading

- Hall, D.O., Cammack. R. and Ra K.K., Nature, 233, 136 (1971).
- Carnahan, J.E. and Castle, J.I. Annu. Rev. Plant Physiol., 14, 1 (1963).
- Mahler, H.R. and Cordes, E.F. Basic Biological Chemistry, Harp and Row, New York (1968).
- Mortenson, L.E., Annu. R. Microbiol., 17, 115 (1963).
- Sokatch, J.R., Bacterial Phys. logy and Metabolism, Academ Press, London (1969).
- Zelitch, I., Photosynthesis, Pho respiration and Plant Productivi Academic Press, New York (197

ntroduction

Our body is essentially made of complex organic molecules like roteins, peptides, enzymes, lipids, to. Besides these organic molecules, consists of certain metal ions which onstitute only 3% of the human ody. These metal ions are sodium, otassium, magnesium, calcium, nanganese, iron, cobalt, copper, zinc and molybdenum.

These metals can be divided into wo groups: the main group elements Na, K, Mg, Ca) and the transitional roup elements (Fe, Co, Cu, Zn, Mo, Ic.). The main group elements are enerally present in our body as free ons, though calcium and magnesium re also present as complexes. Transional metal ions are, however, always omplexed with organic molecules ke enzymes.

Any change in the concentration of nese ions disturbs the physiology of e body. The cleavage of metalgand bond of the complexes of ansitional metals with organic moleules may result in fatal disease. Let represent these complexes as M-L M Metal ion, L=organic molecule ke protein, enzyme, etc.). Any reign metal or any virus in our body ay compete to join with M or L. the virus wins the race, the M-L and is broken and there is an excess peration of a metal ion or the orgac molecule, which may lead to a sease of any magnitude. In Wilson's sease the symptoms are cirrhosis liver, paleness of eyes, and there liberation of copper ions in the ody. These ions are originally implexed with enzymes, but on count of cleavage of copper-enme bond, the copper ions are perated and deposited in liver. They timately become poison for human dy. When an organic molecule enicillamine' is injected in the body, e copper ions are complexed and e disease is cured. A similar type cleavage of M-L bond might be e cause of cancer.

The importance of metal ions for

the body was known even in 1500 B.C., because in those days impotence was treated by aqueous ethanolic solution of rust and anaemia by ferrous salts.

Sodium and potassium

These ions are found widely distributed throughout the body. Sodium is the main cation in the fluid outside the cells, and potassium is found inside the cells. The shock that occurs after severe burning, is observed because potassium ions within the cells are lost. Both ions have the role of keeping the osmotic pressure, on either side of the cell wall, constant. They also maintain sensitivity of the nerves and control muscles. Potassium ions permit heart muscles

Cleavage of metal-ligand bond of the complexes of transitional metals with organic molecules may lead to higher concentration of the metal in the body resulting in fatal diseases



to relax between beats. Sodi chloride is the source of hydrochlo acid for gastric juices and, sodio bicarbonate is a buffer in maintaing the acid-base balance of boffuids and in the transport carbon dioxide. Sodium, as sodio chloride, is wasted in large quantit through perspiration. To replent this loss in summer, excess salt show be taken. Both Na⁺ and K⁺ ic are excreted via kidney, in the uri as salts of phosphoric, sulphuric as uric or lactic acid.

The sodium salt of uric acid insoluble and when deposited in t cartilage it produces gout. Our bodi obtain the supplies of sodium as potassium from plants and common salt.

Magnesium and calcium

Magnesium ions are found complexed with nucleic acid inside the cell and are necessary for nerve impultansmission, muscle contraction are metabolism of carbohydrates. A enzymes which transfer phosphate require a metal ion, i.e., magnesium MgSO₄. 7H₂O (Epsom) acts as purgative because it does not parthrough the intestinal wall, an extract water for its hydration.

Human body requires calcium phosphorus and vitamin D for th formation of bones and teeth (grow ing children need upto 1.5g calcius per day and adults 0.5g). It is als necessary for formation of mill precipitation of milk casein in th stomach, maintainance of the correct rhythm of the heart beat and in th conversion of fibrinogen into fibri to form blood clots. Calcium salt administered to sometimes hasten blood clotting, or conversely sodium and potassium citrate is given to complex the calcium salt and to reduce clotting. Blood donation can be taken into 3.8% potassium citrate solutions. If the calcium level in blood falls, it is replenished by drain age from bones and eventually i causes skeletal bone bending (Osteo

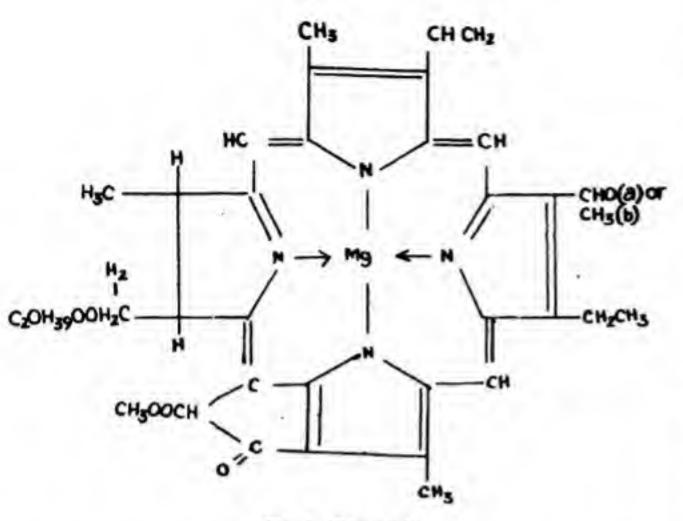


Fig. 1. Chlorophyll

malacia). The regulation of blood calcium is controlled by the parathyroid glands using the hormone calcitonin (a chain of 32 amino acids residue). Administering calcitonin, isolated from parathyroid glands, may prevent osteoporosis (thin brittleness of bone) in the aged people. Calcium deficiency in blood plasma causes muscular twitchings and eventually convulsions (sudden contraction of muscles).

Magnesium is present in plant chlorophyll and calcium in many minerals, vegetables and milk. It is through these resources that our body requirements are met.

Manganese

It is required for enzyme activation in the body. The enzymes that are activated by this metal ion are isocitrate dehydrogenase, malic enzyme and pyruvate decarboxilate. It reaches our body through green plants.

iron

Our body contains 4-5 g of iron; 65%-70% in haemoglobin, 15% stored in liver, spleen, bone marrow, and kidney and the rest is involved in the formation of protein and in oxidationreduction reactions in the plasma. Colostrum and milk are low in iron content; so infants require a reserve at birth which is furnished by the mother prior to birth and is stored in the liver and spleen to last for simonths. Thereafter, the body unable to store it. Excesses are excreted. Bleeding, child-carriage, parturition and menstruation requiremore iron than is usually found in the diet. Anaemia may result if iron in not replenished. This may be achieved by administering ferrous salt which are easily absorbed by the intestine. Alternatively intravenous injection of iron ascorbates and citrates can be given.

If we remove cells from blood, the remaining solution will be plasma it contains less than 0.1% of our body iron. The iron content of plasma varies with sex, the time of day and diet. The normal iron in female plasma is 10%-15% less than in male plasma. They are highest in morning and lowest in the middle of afternoon Night workers have the converse

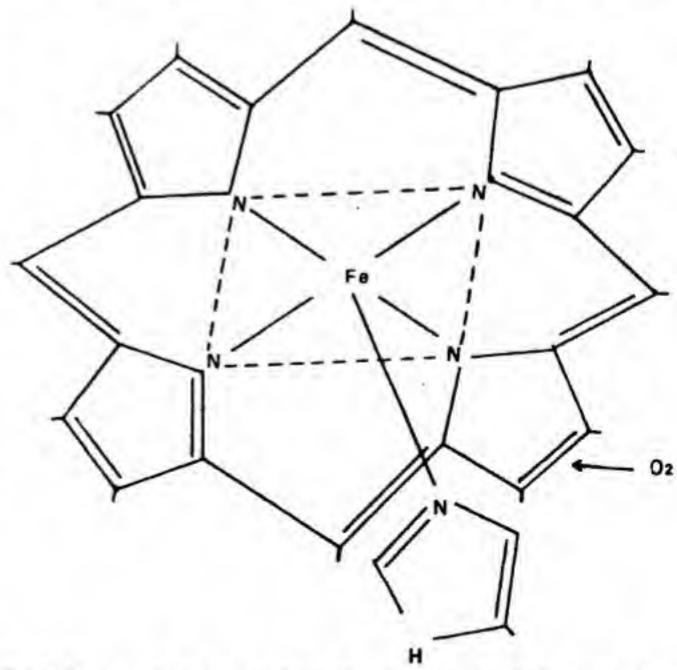


Fig. 2. Diagrammatic representation of the five coordinate iron (11) in hemoglobin (4 bands to porphyrin ring and to imidazole nitrogen from a histidine residue) being approached by a oxygen molecule

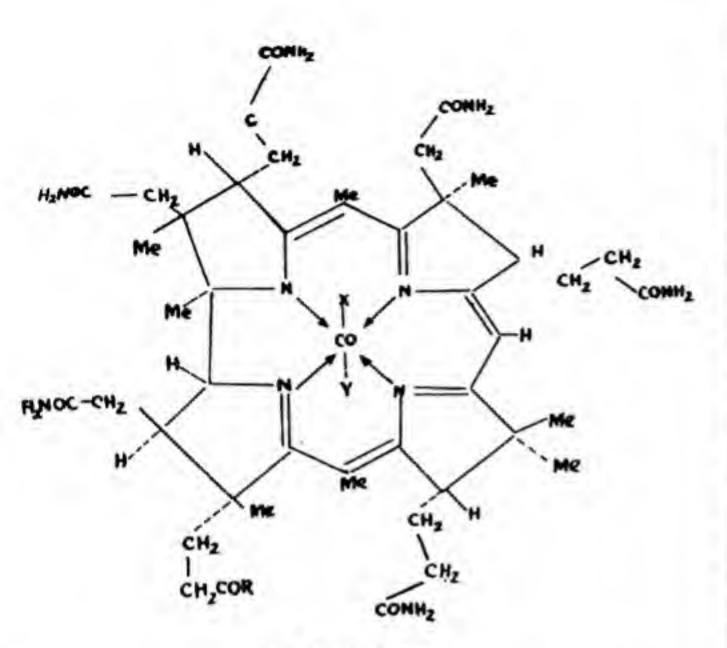


Fig. 3, Vitamin B,

haracteristics. During pregnancy, emales have an iron deficiency beause of foetal requirements. From nid-term onward the plasma iron rops, even though the total iron inding capacity (T.I.B.C.) increases. naemia cannot be treated by adninistering iron unless the T.I.B.C. high or can be therapeutically aised. At birth the infant has a higher lasma iron content than the mother. But its T.I.B.C. is low. So, within matter of hours the concentration rops. It rises slowly over the ext few years until it reaches the ge of five years.

The average life of a red cell is 20 days and 25mg-30mg from are est each day. An equal quantity of on requires to be taken. Pregnant omen who eat meals cooked in on utensils are not deficient in on. Excess intake of iron may cause side effect. Plants, iron utensils, nimal liver are the sources of iron.

obalt

In our body cobalt is necessary for

vitamin B₁₂. B₁₂ or cyanocobalmin is needed to form haemoglobin. Its deficiency causes pernicious anaemia. The B₁₂ present in our food cannot be absorbed through intenstinal wall unless it encounters hydrochloric acid (from gastric juice). Cobalt (II) is used as an enzyme activator. The richest source is animal liver.

Copper

Copper is actually required in the production of haemoglobin. It is found in certain enzymes, which are capable of carrying oxygen as haemoglobin does. The cuproproteins use molecular oxygen as an electron acceptor and most of them contain an even number of copper ions. These cuproproteins are used in oxygen storage for transport to the brain and blood plasma. Copper is stored in liver. Liver is the source of copper. Excess copper if not excreted may be found deposited in eyes. Presence of excess copper in body is poisonous.

Trace elements i human body

TRACE elements or micro elements are as important for the development and maintenance of human body as the major elements are. They are, however required only in minute quantitie for metabolism. Deficiency of these elements is the cause of ailments of various kinds i human system. For instance, lac semitrace element iodin produces goitre (swelling in th neck caused by enlargement of thyroid gland) and mental an physical retardation of infants

These elements are widel distributed in various organ and tissues of the body. Th maximum amount of iron present in the skeleton (1560 mg followed by the amount in brai (580 mg) and liver (530 mg) Copper in brain is 58-81 mg. and in liver it is 59 mg. Most of zin and boron are found in skeleto and muscles, manganese mostly in skeleton (28 mg) and also in muscles. Human skeleton also contains 98 mg of strontium, 14 mg of lead (which is known to b texic for the human body), 7.8 m of boron and 8.6 mg of tin. Cobal also occurs in various parts o the body, though its percentag is very low. In skin only two trace elements are present: boro (2.14 mg) and cobalt (0.11 mg.

Almost all these micro element are present in low amounts in other organs of the body also say in heart, spleen, kidney, brain etc. Strontium is found only in skeleton and in no other organ

N.B

Zinc

Zinc is an essential constituent of several enzymes and its deficiency believed to have led to dwarf formation among some people living in central Europe. Zinc occurs in the rm of several minerals and is btained through plants.

lolybdenum

It participates in biochemical oxiation-reduction as in liver. During the redox reaction Mo (V) and Mo (I) are attached to oxygen conining a ligands. It acts as a cofactor nitrogen fixation bacteria in some ants.

lvents

Seventy per cent of our body

weight (BW) is water: 0.49 BW inside cells, 0.17 BW in interestitial fluid and 0.04 BW in blood plasma. Each day 1.61 BW of water is lost and imbalances in the above soon result in severe edema or dehydration. Whole blood consists of 92% water and 8% solutes (colloids, ions and complexes).

Further reading

- Williams, D.R., Chem. Rev., 72, 203, 1972.
- 2. Ramsay, W.N.M., Adv. Clin.

- Chem., 1, 1, 1959.
- Freeman, H.C., Chem. Comm. 598 (1965), 23 (1966).
- Spencer, J., Coord. Chem. Rev. 4, 475 (1969).
- Ranks F. and Ives, D.J.G. Quart. Rev., 1 (1966).
- Williams, D.R, The Metals of Life, Van Nostrand Reinhold (1971).
- Peisach, J., Aisen P., and Blum berg, W.E., The Biochemistry of Copper, Academic Press (1966) W.E. Blumberg.

NTEGRATED OPTICS IN COMMUNICATION (Continued from page 2017)

rther reading

Stewart E. Miller, An Introduction to Integrated Optics. Bell System Technical Journal, 48, No. 7, pages 2059-2069, Sept. 1969.

Tien P.K., Light Waves in Thin Films and Integrated Optics,

Applied Optics, 10, No. 11, pages 2395-2413, Nov., 1971.

 Pole R.V., Miller S.E., Harris J.H., and Tien P.K., Integrated Optics and Guided Waves—A Report of the Tropical Meeting, Applied Optics, 11, No. 8, pages 16751685. August 1972.

Tien P.K., Martin R.J., Wolfe R. Le Craw R.C., and Blank S.L. Switching and Modulation of Light in Magneto-Optic Wave guides of Garnet Film, Applied Physics Letters, 21, No. 8, page 394-396. October 1972.

NEWS AND NOTES (Continued from page 246)

Medicine Nobelist Dr. Whipple passes away

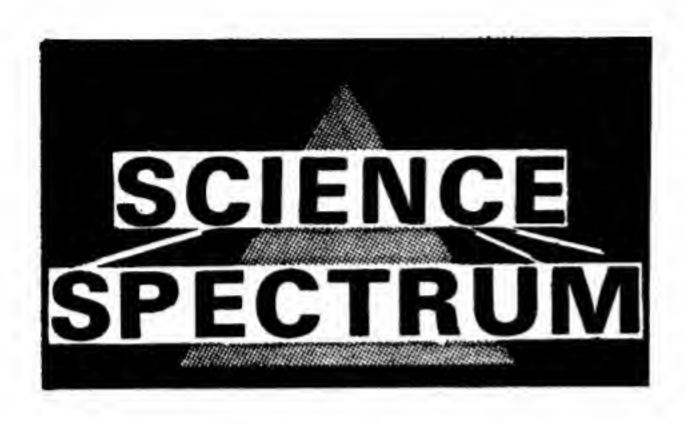
DR. George Hoyt Whipple, cowinner of the 1934 Nobel Prize in Medicine and pioneer of medical eaching and organizer of medical ducation in the U.S.A., died on February 1, 1976, in Rochester, New York, at the age of 97.

Born on August 28, 1878 in Ashand, New Hampshire, young Whipole graduated from Yale University in 1900 and received his medical degree in 1905 from Johns Hopkins University. After some years of training and teaching at this University, he went to the University of California as Professor of Medicine becoming its dean in 1920. In 1921 he came to the University of Rochester where he organized its new medical school, serving as its first dean and retaining that position till 1953. He served in various capacities in the development of the Rockefeller Institute of Medical Research, which is now Rockefeller University. As one of the American medical students who received a grounding in European-style medical science at

Johns Hopkins University, perhap the first American medical school to adopt this method, Dr. Whippl spread it to other institutions.

Working independently, Dr. Whip ple discovered that previously in curable pernicious anemia could be controlled with a liver diet. This paved the way for the successful treatment of pernicious anemia be Dr. George R. Minot (1885-1986) and Dr. William P. Murphy 11 shared with them the 1934 Nobel Prize in Medicine and Physiology Dr. Whipple's research included for mation and destruction of bile pigments and haemoglobin.

St. Barnabas Hospita Bronx, New York



The interplanetary space

Our special star, the sun, is in all respects the cynosure of the colar system. Though far away from the planets and in a near vacuum pace, the sun bears full responsibility for whatever takes place in interchantery medium and even planetary atmospheres. For instance, one is tweet of the beautiful but bizarre thenomena like polar auroras, magnetic storms and Van Allen

radiation belts that occur in the earth's atmosphere because of the energetic A of sun. stream by the sun particles ejected moving at supersonic speeds, called the 'solar wind', can be accredited with these and various other phenomena that are observed on earth, other planets and in interplanetary space. This wind which flows steadily away from the sun and which

during solar flares (outbursts energy) is more energetic than usus creates radical and complex change in temperature, density, particle and magnetic fields in the interplanetary space. So, it is relevant to discuss solar wind before coming to the effects it brings about the space.

Solar wind

For the present purpose, it enough to say that surface of the st is made up of nozzles, exactly li those in rocket engines, which eje out hot matter at supersonic spee (speed above the velocity of sound If the sun were stationary, the ou flowing gaseous streams wou appear as in Fig. 1(a). But the sun is rotating (S.R., Dec., 75 entire configuration the outflowing streams appears as Fig. 1(b)-like the water spouting out of garden hose nozzles. It apparent, to reason that, like th water is sprinkled all around l a garden hose, the outflowing gases are sprayed in all dire tions in the interplanetary spain the form of an Archimeder spiral (Fig. 2).

The question that arises is: Wh

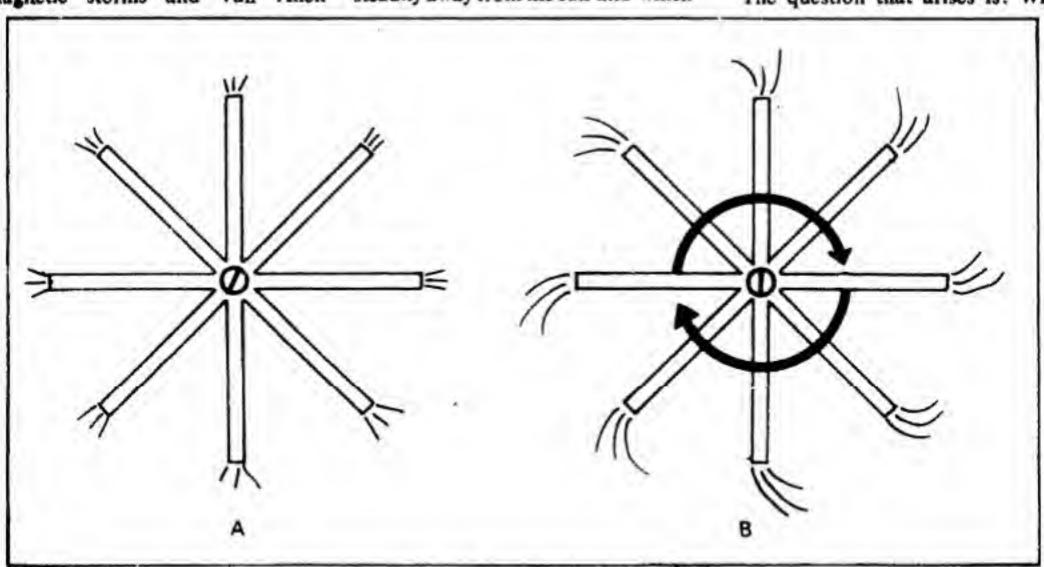


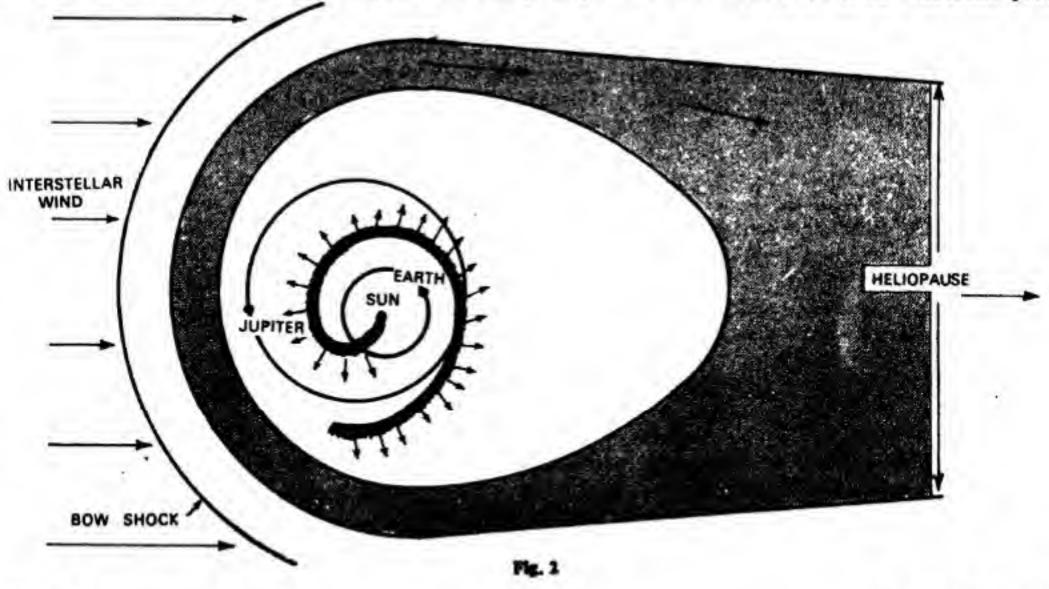
Fig. 1

does not the solar wind, as it should, diffuse into the interplanetary space as soon as it is ejected out of the nozzles on the surface of the sun? The answer comes under the domain of plasma physics. The solar wind is in a gaseous plasma state—full of ionic stuff—called the fourth state of matter, because the properties it exhibits at ordinary conditions are different than what the other states exhibit. For instance, when a magnetic field is applied to the plasma, it conforms itself to the magnetic lines of force and almost gets 'frozen' in it, particularly when the field is strong. When it is not so, the plasma does not conform to magnetic lines of force; instead it distorts them. In the vicinity of the sun where the magnetic field is strong, the material that the nozzles eject conforms to it and so is swung round the space. As the distance from the sun ncreases, the magnetic field strength decreases and, as a result, the firection of the plasma flow predominates the magnetic lines of force o form the Archimedean spiral.

Within the last decade or two many spacecraft, e.g., Helios, Mariner, Pioneer, etc., were launched to study the solar wind inside and outside the earth's orbit around the sun. It has been observed that the wind mostly contains ionised hydrogen; the maximum flow is radially outward from the sun; its velocity range is 350-800 km/sec, its density is 5.4 ions/c.c., ionic temperature is about 160,000 °C, and the average strength of the magnetic field is 6 gammas (six hundred thousandth of a gauss). On the whole, the direction of magnetic field lines resembles the garden hose configuration but is variable. Properties of the solar wind vary with distance in a simple and continuous manner. For example, between I A.U. to 5 A.U. (one astronomical unit (A.U.) = the average distance between sun and earth = 150 million km) the average velocity of the wind varies slightly, and with increase in distance the range of fluctuations diminishes gradually. It is because of the intermixing between fast and slow moving particles to equalize the speed. The average temperature falls

by a factor of two; and the ion density varies in accordance we inverse square of the distance from the sun. At 5 A.U. the magne lines of force are nearly in the plat of the solar system and are almost a circular orbit around the sun.

This is the picture patched togeth from the data available from vario interplanetary missions sent towar planets. Research is in progress probe deeper into interplaneta space. Eyes are presently set on the data that, it is hoped, would be se by Pioneer-10 by 1979, when it would be nearly 20 A.U. away from the su Further, there are many problem faced by scientists in probing th interplanetary medium at variou angles and distances. Till nov majority of the data collected as about the solar system plane and no from a wide angle. However, from other studies, e.g., the observation of comet's tail (the cause of which the solar wind), much has been gair ed about the solar wind at highe latitudes of the sun. A conclusio has been drawn from this study tha the outflow of the wind is not spher



ally symmetrical; it depends on the plar latitude.

Another obvious but verily calculaed idea is that of the presence of eliopause. It is known that the un, with its entourage of the orbiting lanets, is moving through the space t a velocity of 20 km/sec towards an naginary point in the space called ne solar apex. Because of the diffrence in densities (interstellar space ensity is I atom/c.c., whereas verage interplanetary space density 10 particles/c.c.), the sun, like the ow created along the front streamned edges of a boat moving through ater, creates a bow—a hypothetical oundary surrounding the stem, whose frontage facing the olar apex (Fig. 2) is spherical and the ackside tapers off like a tail. The eliopause boundary facing the apex om the sun, as theoretically oncluded, lies between 5 A.U. to 00 A.U. The data transmitted by loneer-10, when at 10 A.U., howver, does not indicate such a transion boundary.

nterplanetary medium

As the solar wind blows through ne interplanetary space, it acts as a nedium for higher energy charged articles as well. Before it is disused how it influences the particleow the basic intricacies of the solar ind as a medium need elucidation.

First, the medium has on an verage some 10 particles of matter er c.c., so its mean free path is 100 .U. The mean free path is the verage distance a particle would averse before colliding with another article. It depends on the density f the medium: the more dense a edium, the lesser the distance particle would traverse before olliding with another particle, ecause of the 'crowding' of the parti-Second, the medium has es. agnetic fields which, of course. ontain irregularities. The irregu-

larities are like 'kinks' in the tautlines of the magnetic fields. Third, motion of a charged particle through a magnetic field is naturally directed along the lines of force, but with a difference. For this, consider a helical spring. If it's axis represents the magnetic lines of force, then the coiled wire of the spring would indicate the path taken by the moving particle under the influence of the magnetic field. Further, the radius of the helical path of the moving particle would depend directly on its momentum and inversely on the strength of the magnetic field. So, particles with varied energies would have varied radii of helixes in a constant magnetic field strength, or vice versa.

What would result, on the whole, of the above three features of the medium is as follows: Particles moving in helical orbits along magnetic lines of forces would not collide with another one for considerable distances (nearly 100 A.U.), and while conforming to the magnetic lines of forces would encounter 'kinks'. There would then be interactions. To understand them, consider an analogy.

Imagine the spiralling particles as a spinning ball of the radius same as that of the radius of the helical orbit and the 'kink' a spherical (approximately) rubber ring of the same order as the kink. If the size of the ball is substantially smaller than the size of the ring, the ball would easily pass through the ring. i.e., a particle would move along the magnetic lines overcoming a 'kink'. If the size of the ball is substantially greater than the size of the ring, it may stretch the ring to its own size and pass out, but with a slight change in direction because of the interaction. Lastly, if the size of both are nearly the same, one of the following phenomena may happen: either, because of the same size, the ball may get rebounded or reflected exactly opposite to its direction of incidence on the ring, or, because the ball may strike at one edge of the ring, it may get deflected to an angle. The last phenomenon, which a particle of orbital radius the same as that of the kink's would get scattered in any direction, is called scattering by magnetic irregularity. So, the behaviour of particle not conforming to magnetic lines of force are more or less dictated by the scattering component of magnetic irregularities.

Measurements of the magnet field at various places in the inte planetary space indicate many irre gularities in both direction and mag nitude of the magnetic fields. Th stream of particles that flo through the solar wind, therefore get scattered, or conform to th magnetic field, in accordance wit the energies they had and the loca magnetic field strength. Followin are the observations made abou cosmic rays and other high energ particles in the interplanetary space (Scientific American, Sept., 1975).

Cosmic rays. The intensity of th secondary products of the rays under goes a maxima and minima in regular cycle of eleven years. A has been theorised, these rays are o galactic origin. The intensity constant over periods of millions of years. Even in the interplanetar space which remains unaffected b the sun, the intensity does not var with the eleven year solar cycle Further, their intensity on the eart reaches minima when solar cycl reaches maxima and vice verse In final analysis, this behaviour ca be explained as follows. The sun' magnetic field, which is radiall outwards in a garden hose fashior acts as a barrier to the incoming part cles because of the irregularitie When the solar act present in it. vities are at their peak, it is quit obvious that magnetic fields are carried to greater distances and are relatively stronger. As a result, the total scattering component of magnetic irregularities is radially outward from the sun. So when the cosmic rays stream in, they are scattered or one can say deflected. A major part, particularly of weak energies, does not reach the earth. On other occasions, during the various phases of solar activity the intensity of the rays varies accordngly. It has been observed that the intensity of cosmic rays on earth at solar cycle maximum is half of what obtained when solar activity s at minimum. This factor is greatest at lower energies, and it is almost negligible above 1011 eV (electron-volts) of radiation energy.

Direct measurements carried by Pioneer spacecraft indicate that cosmic ray intensity gradient, or the rate of change of cosmic ray intensity with distance, is zero between I o 8 A.U., which, according to theoreticians, should increase by a margin of 60% over the same distance. This inaccuracy brings about another setback to the calculation of the probable distance of heliopause from the sun, which is A.U. It claims that this layer s much far away from the sun, say, a hundred A.U. In a way, this supports Alfven's theory, who had long ago attributed the major inflow particle of energy < 1011 eV) of cosmic rays to sources within the confines of the solar system. He claimed that cosmic rays were, in fact, ions of solar wind that have been accelerated to high energies by planetary magnetospheres.

High energy particles. Electrons, protons, nuclei of helium, carbon, nitrogen, oxygen, and heavier atoms emitted by the sun have been observed. They have energy range between a few thousands to hundreds of millions electron volt. It occurs usually

when the sun spews out huge quantities of energy in the surrounding
space, the phenomenon known as
solar flares. These particles, which
were previously incorrectly called
solar cosmic rays, are accelerated to
high energies. The acceleration is
attributed to the collapse of magnetic field at the site of the
flare, i.e., it takes place during the
early "flash" phase of the solar flare.
The particles then escape from the
sun and diffuse outward while interacting with the scattering centres
of the interplanetary medium.

Intensity-time curves of fast moving electrons and high energy protons are fairly smooth, but those of lower energy protons and heavier ions are highly complex. reason for the former is diffusion process in the interplanetary magnetic field, and for the latter complex convective-centres, shock waves and other discontinuities the interplanetary medium. Some energetic solar particle events also take place, and some are so intense that they may hazards for the future space-missions.

Electromagnetic waves. The electromagnetic waves produced by the sun, planetary atmospheres and sources outside the solar system are affected during their travel through the interplanetary space. It is known that plasma is ion matter: there are heavy ions about which electrons (bound to ion oscillate, with a frequency call plasma frequency. This frequency of oscillation depends upon to density of the electrons, a so the plasma frequency varies from point to point in accordance we the electron density of the location.

When an electromagnetic wa strikes plasma with a frequen less than that of the plasn the plasma would absorb it; if frequency is greater than t plasma frequency of the locati it would be propagated. In t vicinity of the earth. t plasma frequency is 20,000 her i.e., the electromagnetic wa coming from the surrounding spa below this frequency would not received by us. Moreover, the fa tor by which an electromagnetic wa would be propagated through t plasma would also depend up electromagnetic wave frequency the higher the frequency t higher would be the propagati factor. In other words, the degr of transparency of the space become higher with higher frequency. Abo 100 million hertz a traversing wave not at all affected by the inte planetary space.

DILIP M. SAL

The leap second

THE concept of 'leap second' originated at a meeting of the International Radio Consultative Committee (Comité Consultatif pour International Radio, CCIR) of the International Committee of Weights and Measures (Comité International du Poids et Mesures, CIPM) held in

Geneva, Switzerland, in Februa 1971. A new Co-ordinated Univer Time (Universal Temps Coordon UTC) was adopted by CC with effect from January, 1972. the new UTC system, the duration a minute is changed from time time by the International Ti ireau (Bureau du International emps, BIT) to 61 or 59 seconds as ggested by CCIR in 1971. This is terpreted as leaping of a second in time scale.

Just as our calendar does not get it of step with seasons because of ldition of a day in leap years, so so a leap second helps to maintain e recorded time of a clock in nison with a mean solar day by casional addition to or deletion of 'leap second' from a day. The ility of a 'leap second' will be ident from the attempts to bridge e gap between solar time and atoic time as elucidated in the followg paragraphs.

In 1954, CIPM standardized 'secd' as 1/31 556 925.9747 ert of the tropical year 1900. The tal duration of a solar year remains actically the same, but the duraon of a day changes due to polar otion, tidal friction of oceans and me other uncertain factors; they nd to retard the spin of the earth. it do not affect its orbital motion. mean solar day is found to increase about 2.74 milliseconds per year e to tidal friction and other factors e The Changing Time, S.R., Sepmber, 1974, Letters). So the duration a second changes in consequence. nese considerations led CIPM to place in 1964 the above definition second by the following one.

"The second is the period of duraon of 9 192 631 770 vibrations of e transition frequency of caesiumom between the hyperfine lines of ground state $[(F=4, m_i=0)\rightarrow$ =3, $m_t=0$) when unperturbed by ternal fields." This is a 'second' mifying an International System ysteme International. S.I.) of se unit of time.

Atomic clocks are based on the e of extremely regular waves of ctromagnetic radiation due to the ove energy change (quantum tranion) of caesium-133 atom; these

waves are counted from individual atoms when they are in phase with one another. This clock is a combination of an electronic clock and an atomic oscillator. The atomic time (1964 definition) is apparently constant, while the solar time (1954 definition) is variable with advancing years.

Astronomers and scientific workers always refer to a Universal Time (U.T.) which corresponds exactly with Greenwich Mean Time (GMT). the time of reference at Greenwich, U.K. This UT is also used in air and sea navigation. Various observatories of the world record the UT which is found to differ slightly because of the polar motion. The initial values of universal time obtained at these observatories are termed UTO. A correction is added for each observatory to convert UTO to a common time UT,. An empirical correction due to slowing down of earth's spin changes UT, to UT. The latter, obtained from atomic clock, leaves us in a position of having the clock rate not exactly commensurate with the length of a day. An UTC (Universel Temps Coordonne) was introduced from 1960 in which the clock rate has been offset yearly from atomic time. This offset changed yearly in its value from 1960 to 1971, and the variation ranged from -1.5 to -3 parts per 10". Since this yearly change of UTC necessitated actual changes in equipment and also interrupted sophisticated systems, CCIR recommended a new UTC system.

Time is kept within about 1/2 second of UT, by resetting a clock on new UTC by exactly one second when necessary. Clocks obeying



"Born on Feb. 29, she counts her age in terms of leap years. She is only I leap years old today."

new UTC system are set once ever year. This is achieved by resetting the clock (normally, retarding it on a particular day by a discret second towards the last second o that day. This addition (or dele tion) of a second leads to the concep of a 'leap second'. The occurrence of leap seconds, however, are no predictable in detail due to variou uncertainties. The day on which leap second is introduced is finall decided by BIT as need be. This infrequent change in adding (or dele ting) the last second of a day lead to a situation of having the clock rate not exactly commensurate with the length of that day. BIT refer to an International Atomic Time (Temps Atomique International TAI) based on the synchronized time of 50 highly accurate atomic clocks around the world.

> SUDHISH K. MUKHERJEI Department of Physic. Jadavpur University Calcutte

Separation of isotopes using laser single photon processes

THE method of separation of earlier (S.R., Aug. 19., 1975, p. 375), isotopes using lasers, described in which one of the isotopes is preferentially excited by the absorption of photons from a laser and subsequently ionized by photons from another source is now known as the two photon process. Two novel methods of separation using photons from a single laser (single photon processes) have been used recently.

A molecule possesses energy due to vibration of the constituent atoms. These energy levels are also discrete like the energy levels of electrons. The frequency of vibration in the different modes depend upon the masses of the constituent atoms. If there are two types of molecules in which one of the constituents is a different isotope, their frequencies of vibration as well as the energy levels differ very slightly. This difference is usually small as compared to the spread in the frequency of radiation of photons from ordinary sources. Molecules can be dissociated (broken) into their constituents by the absorption of photons of right energy. When ordinary radiation of the suitable energy is incident on the mixture both the species are dissociated. However, by using lasers, it is now possible to get photons with a frequency spread of less than one part in 1010. With such a source of suitable energy one can preferentially dissociate one of the species only in the mixture. It has been reported in Physics Today, July 75, pp 18-20, that several light isotopes like those of sulphur, boron, chlorine, etc., have been separated by this process. For example, to enrich Chlorine-35 the compound dichloro carbon sulphide (CSCI,) is used. Prepared with ordinary chlorine it contains the two species CSCl,28 and CSCI287 in the ratio 3:1. When the mixture is irradiated with radiation from a continuous wave argon laser, whose emission at the wavelength of 4657.84°A corresponds to the absorption peak for CSCI. For a few hours, the proportion of the Clar molecule gets reduced by 5%. Likewise, when the same mixture is irradiated with radiation from tunable dye laser at 4505.5°A the CSCl₂²⁶ species gets dissociated and in a few hours the percentage of the CSCl₂²⁷ gets enriched by about the same amount.

Another approach in the single photon process is photochemical in nature. In this, the molecules are not dissociated but are excited to a higher vibrational energy state in which they undergo chemical reactions more favourably than in the ground state. Using lasers one species of molecules in a mixture of like molecules, with different isotopic constituents, can be excited preferentially. They will therefore

participate in the chemical reaction more readily than the rest of the molecules aiding the separation. is reported in Applied Optics, No 1974 p 2506, that of the two speci of methanols, CH₂OH and CI OD (one with the ordinary hydroge and the other with heavy hydroger the first species can be readily exc ted using the hydrogen fluoride las at 2.7 microns that falls in the absor tion band of the OH bond. Ti excited compound readily reacts with bromine and the products are easi separated leading to enrichment the methanol with heavy hydroge

PROF. V. SRINIVASA
The American College
Madurai T.

Mercury pollutes environment

TN 1953, a mysterious ailment I broke out amongst the families of fishermen and workers in a plastics factory in Minamata, a sea coast town in the Japanese island, Kyushu. Forty people died, seventy were seriously disabled and nineteen babies were born with congential defects. Six years later, the cause of this disease was identified as large amounts of mercury compounds discharged into the Minamata Bay by a plastics factory. The mercury compound contaminated the fish and shellfish and the people who regularly ate such foods became diseased. Ten years later, a similar incident near an industrial plant at Nigata, Japan, caused the poisoning of twenty-six people out of which five died. Similar incidents have also

been reported from Iraq, Pakista Gautemala and Italy.

News of Japanese incidents spread to Scandanavia in the early sixtic and in 1965 the Swedish Government raised alarm against the use of mercury compounds in seed dresings. Next year, their use as simicides in paper industry was also banned. These countries, however continued to produce these chemical even after their sale was declared illegal in Scandanavia. These chemicals were sold widely in the U.S.A. Canada and India. They, however represented a relatively minor sound of mercury pollution.

Sources of mercury pollution

The world production of mercu is estimated at 9000 tonn 1 metric ton=1000 kg) per year, nost of which comes from Spain, taly and the U.S.A. India imports bout 3000 tonnes of mercury every ear, most of which ultimately finds ts way into the environment. The argest consumer of mercury in ndia are the chloralkali plants which nanufacture chlorine and caustic oda. They discharge approxinately 1300 tonnes of mercury into he environment every year. This is y far the largest source of mercury ollution. Paper and pulp plants which use mercurial slime control gents also discharge substantial mounts of mercury into the environnent. The emissions from such lants are partially responsible for he atmospheric contamination. The najor contribution, however, comes rom the combustion of coal. Large mounts of mercury are used in aints to prolong their shelf-life. he magnitude of pollution from his industry is not fully known.

The major source of mercurial vater contamination is its agriculural applications. Over 70 merury compounds, known to have
een used to control seed-borne or
oil-borne fungal diseases, get washed
with rain and irrigation waters and
ollute the nation's waterways. Merurial water contamination is also
aused by plastics factories using
nercuric chloride as a catalyst.

Mercury also finds sizable applicaion in electrical equipment industry. Usually mercury is present in sealed witches and control devices which re safe as long as they are not broen. Mercury compounds are also ound in many other products such as floor waxes, furniture polishes, abric softeners and even a very rell advertised face cream. All these expresent potential health hazards.

lazards of mercury pollution

The relative stability of mercury d to a common belief that living organisms cannot metabolize the element mercury or its inorganic compounds to produce new substances and, therefore, mercurial wastes can be safely dumped into the environment without any effect on the biosphere.

In the last decade, however, Swedish scientists discovered that bacteria could convert relatively harmless form of mercury deadly methyl mercury. It was also discovered that the 0.03 ppb to 2.0 ppb (parts per billion) mercury found in sea water can casily be concentrated to 500 ppb by the time it reaches to a large fish. The mechanism of methylation is still under investigation at the Swedish Air and Water Pollution Laboratory. However, it is now well established that living organisms can convert elemental mercury to both mono-methyl mercury (CH₂H₂) and di-methyl mercury (CH₂H₈CH₃). The latter gets ionised at low pH to give the more deadly monomethyl form.

Methyl mercury and other alkyl mercury compounds are highly toxic. These compounds are efficiently absorbed into the body from the digestive tract and also through the skin and lungs. Alkyl mercury compounds are particularly toxic to the nervous system affecting sight, hearing coordination and mental sharpness. The toxicity depends on both the quantity of mercury absorbed and the site of its accumulation in the body. A dose as low as 1 mg to 2 mg of mercury (as alkyl mercury) will produce poisoning symptoms in an average man. Some individuals may react at still lower dosages. Prenatal exposure produces symptoms to cerebral palsy (brain paralysis). Congenitally deformed babies may be produced even by smaller doses—as in the Minamata tragedy. A dose of 5 mg per day is lethal.

Alkyl mercury compounds bind to

proteins hamper their norr biological activity. These compour inhibit cell division a breaka cause chromosome Chromosome breakage occi doses too low to produ overt symptoms in normal adul but has a distinct effect on unbo babies.

Mercury build-up in food chain

Mercury that escapes in the was waters from the various sources s tles down in the sediments of lake and rivers. Marine phytoplankt organisms, such as unicellular alga seem to pick up mercury just having it stick to their surface Several commonly used mercur fungicides produce significant redu tion in the photosynthesis of ph toplankton, e.g., 0.5 ppm mercus ion concentration in water results 50 " reduction in photosynthesis the giant kelp, Macrocyclis pyrifer The crabs accumulate more me curic chloride in their gills than bloo but the latter excretes it more slow Other small organisms apparent ingest the metal. The bottom fee ing fishes eat upon the small org nims and are, in turn, eaten by t larger game fishes. Mercury b comes increasingly concentrate with each successive step in the foc chain and is highest in the game fis This build-up in concentration ma be as high as 5000 times.

A similar build-up can occur the food chain for birds, but on lesser scale. Experiments with birds have shown a tendency to muthylate and accumulate mercury, but the problem is not believed to be a serious as mercury pollution of the aquatic and marine environments.

Mercury safety standards

The absorption and retention of mercury vapours or dust by th human body was recognised as definite health hazard centuries ago as early as 1600. A.D. Opinions differ as to what concentrations of vapour will make the air unsafe to breath. In California (U.S.A.) permissible limit is 0.15 mg/cu.m. India has not set up any such standard so far, as the problem is not considered serious enough—except in industrial plants using mercury, where adequate precautions are apparently observed.

The Food and Drug Administration (U.S.A.) confiscates all foods with more than 0.5 ppm methyl mercury, as undesirable for even a single meal. Sweden has set higher permissible level as I ppm for mercury in the total diet, with a recommendation that fish be eaten only once a week. The Swedish National Institute of Health has recommended a standard of 0.2 ppm with free fish consumption or 1ppm with effective restriction on fish consumption.

The U.S.A. and U.S.S.R. have tentatively adopted a standard of 5 ppb in drinking water. The standard appears very stringent for Indian conditions, but some other standard is definitely called for.

Japan has set a limit of 10 ppb for methyl mercury in industrial waste water. The Washington State Department of Ecology (U.S.A.) set a limit of 50 ppb in 1971. India has not set any standards in this regard, but a standard is urgently called for, particularly in view of the 1300-1400 tones of mercury being discharged into our environment annually by our chloralkali industry.

The problem of escaping mercury 'however, can be solved. Japan and the U.S.A. have already begun to operate mercury cell chloralkali plants without any mercury discharge into the waste water. In India, D.C.M. has introduced a 'diaphragm cell' which is both cheaper and pollu-

tion free. But even if all current sources of mercury pollution are stopped, the mercury already reached in the environment will remain a problem for a long time. Bacteria will continue to methylate this mercury and fishes will continue to concentrate it. Implementing adequate standards and safeguards at this stage will, however, substantially

reduce the risk in the most affect areas.

DALJIT SIN

College of Agri. Eng

Punjah Agri. Univers

Ludhia

IQBAL SIN
Poole Hospit

Nunthorpe, Middleshorou

Teeside/U

Alicorn or the horn of the unicorn

M OST people are familiar with the unicorn, the mythical animal, traditionally resembling a small-statured horse which characteristically bore a single, straight and forward-pointing horn on the top of the head between the ears. Not all are aware though that this horn is called an 'alicorn'. For those who believe that the unicorn actually existed, Odell Shepard, author of a famous book on the subject, mentions that its original home was the Lost

Atlantis, and that it was destroyed the floods that submerged the Atlan continent.

In India there is a record to Goddess Durga was depicted having a unicorn as her vehicinstead of the present lion. It imaginary animal seemed to he the body of the wild ass and the ho of the Indian rhinoceros. In Chica unicorn is considered as an animodoming from heaven as an omen a beneficient reign, or the birth



Fig. 1. Virincapture of unicorn

great man. Pictures of the unicorn e hung in the women's quarters of illions of Chinese houses in the ope that they may exert prenatal fluence and induce the birth of eat men. The Oriental unicorn is aced on a higher level as an object reverence and embodiment of odness and it exists for its own ke, and not merely for the advanges obtained from its horn. In e western world, on the other hand, e importance of the unicorn was rimarily because of the much valued orn believed to have come from the imal. The alicorn is not smooth atside as it is covered with regularly iralling shallow grooves and ridges hich make it asymmetric. The folwing account relates to this handedess (left or right) of the alicorn. Suffient evidence is now available that e so-called horn of the unicorn is othing but the tusk of the arctic hale, the narwhal (Monodon monoros). The peculiarity of this tusk s in the fact that it is always shaped te a left-handed screw. Even when e animal in very exceptional cases ossesses two tusks, strangely, both of em show similar left-handed gyre.

he legendary unicora

The legend of the unicorn is scient. It is referred to in the Bible several places. It also appears in ancient natural history book called e Physiologus written by Ctesias. is mentioned in this book that the nicorn is a small but very fierce nimal, agile with one sharp horn on is forehead and that no hunter is ble to catch him by force. The nicorn was alleged to be a male. The mous virgin-capture story which tesias as well as many old authors te is that men lead a virgin to the eart of a forest where the unicorn es, and leave her there alone. hen the unicorn sees her, it runs upto r, puts its head on her lap and later es to sleep (Fig. 1). The hunters

who are watching from a distance advance silently, pounce on it and capture it. The belief in the existence of the unicorn by the people of the middle ages was created by the western traders, missionaries and others who travelled to the Orient. Odell Shepard gives a vivid analysis, how the rhinoceros of India and the Far East, and the oryx of Arabia and N. Africa went to the making of the image of the unicorn. For almost 800 years people of Europe and England held the horn which was believed to be that of the unicorn as an embodiment of majesty and a symbol of strength and power, strong enough to resist all evils such as diseases and poisons. Consequently, the horn became incredibly priceless. Shepard writes that in the 15th and 16th centuries, a unicorn horn was worth ten times its weight in gold. This fabulous value was mainly due to the rarity of the horn. At that time there were about a dozen famous horns kept in churches or monasteries or with the royalty. The most famous of the alicorns, as they were called, was the horn of St. Denis, near Paris, which was 2.10 m long and weighed 4.85 Kg.

It is described as smooth all over and marked by bands running from end to end as on a sna shell. Though the spiral ridges have been smoothed away, the grain of the ivory may still be seen to run in clockwise spirals. Other famous alicorns are those which belonged to the Medicis, Pope Clement VII Pope Julius III, Emperor Theodor Ivanovitch, the great 'Horn of Windsor' of Britain and a few others.

Importance of alicorn

The horn fetched fabulous price even in the form of small pieces of powder as its prophylactic propertie were believed to be miraculous. true alicorn was considered an anti dote against poison and pestilentia fevers and also against bites of madogs and stings of scorpions. It mediaeval feasts, an officer of th household of a king or noble carrie the alicorn about the table, and touched the food and drink befor the royal meal began. For th ordinary man who could not affor the alicorn even in powder form, the water commonly called 'Eau d licorne' was available. It was th water in which the alicorn wa

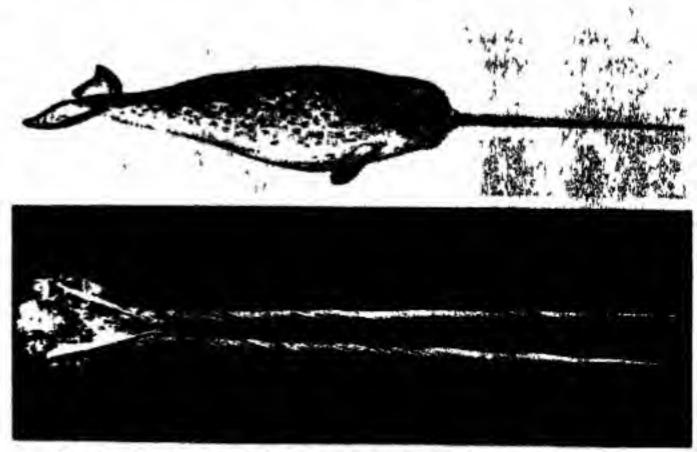


Fig. 2. (a) Narwha litearing a single task (b) Rare skull of narwhal having two tasks, both twisting clockwise

dipped. Adulteration and faking of unicorn's horn was quite prevalent in those days and, one could say, human nature has been the same in every place and time. Faking was mostly done in the sale of the powdered horn and in the fragments. Horns of other animals, stone-chips and even stalactites were substituted.

The true "alicorn"

One lone voice that refuted the power of the alicorn was that of Andrea Marini of Venice who wrote in the 16th century in his book Discorso that the alicorn was no better than other horns and it could not remove or detect poisons, but his voice did not reach the masses to change the universal faith in the alicorn. At the end of the 16th century. Ambroise Pare, a physician in the court of Catherine de Medici showed the ineffectiveness of the alicorn by giving it to poisoned pigeons. In the 17th century, Boethius de Boodt, Caspar Bartholinus and Ole Wurm asserted that the horn-stone (lapsis ceratites) which are sometimes petrified wood, had the same medicinal properties as the alicorn. Ole Wurm, an eminent zoologist of Denmark in his Latin dissertation in 1638 described the alicorn as the tusk of the sea animal narwhal, a small arctic whale. Wurm proved his point by exhibiting the cranium of a narwhal with one huge



Pig. 3. British Royal Coat of Arms

tooth at its side. As the traders in alicorn in those days were his countrymen and though exploring the truth about the horn meant cutting the income to his country, he held fast to his views. This scientific revelation did very little to shake the blind superstition about the alicorn. People simply argued that if there were a unicorn in the sea, there could be one on the land as well. The French Revolution swept off this blind belief. The lists of drugs issued by the English Royal Society of Physicians in which the alicorn found an important place had dropped only in the edition of 1746.

The adult male of these marine mammals is 3 to 5.5 m long and its single tusk of pure IVOLY which grows from the left side of its upper jaw is almost half the animal's body length, and always twisted left-handed (Fig. 2). In rare cases the narwhal develops another tusk on the right side whose grooves also show a left-handed twist. In females, usually both teeth are short. Like the horns and antlers of other animals, the tusks are connected with sexual selection. In the Hamburg museum one could see the oldest specimen of a narwhal, a pregnant female with two tusks, both approximately 2.1 m long (Fig. 2). The animal was said to have been in 1684. The brought there composition of the tusk of the narwhal is the same as that of the elephant tusk. But its universal left-handed gyre (even when two tusks develop in an animal), continues to puzzle scientists. A great English biologist, D'Arcy Wentworth Thompson, author of the classical On Growth and Form, gave the following explanation: The narwhal tusk grows continuously from a fleshy pulp in the jaw, and this pulp imparts the one-sided gyre to the tusk. The curious anomaly in this case is that when a narwhal has two



Fig. 4. The bunt of the unicorn tapestre
the Cloisters, the metropolitian Muse
of Art, New York

tusks, the twist of each is in the sa direction. Thus, they are unit all other paired spiral structures the biological kingdom which alw twist in opposite directions, twin horns of cattle, double hun hair whorls, etc.

Unicorn-in emblems and art

On account of the value and rare powers attributed to the unico this imaginary animal has b honoured by depicting it in m Coat of Arms and emblems of gove ments, institutions and organisation in tapestries, as well as in works art. In the British Royal Coat Arms, the central shield is be supported by the English lion the Scottish unicorn (Fig. 3). Scottish emblem has two unico No significance seems to have b attached to the handedness of gyre of the tusk. It is surprising t the unicorn in the two versi of the British Coat of A (printed the same si On of paper which was supplied the author) has its tusk twis clockwise in one and counter-clo wise in the other. Even in so famed tapestries, the carelessi regarding the gyre of the alic

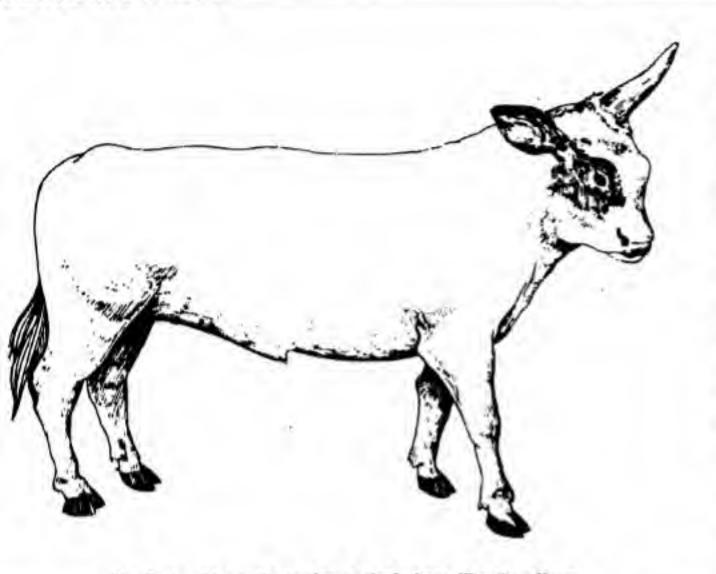


Fig. 5. Ayrshire bull sporting a single horn like the alicorn

ontinued to appear. As for example, f the series of six tapestries in the luny Museum in Paris, titled "The ady with the Unicorn", in four (the mell, the Touch, the Taste and the Desire), the horn is left-handed as ne tusk in narwhal, and in the rest he Sight and the Hearing), it is ight-handed. 'The Hunt of the Inicorn' is another set of seven amous tapestries preserved at the loisters, The Metropolitan Museum f Art in New York. The unicorn ppears in all but the first tapestry. n the second, fourth and the seventh Fig. 4) tapestries, the horn of nicorn is depicted with right-handed rooves, and in the fifth tapestry the yre is left-handed. In the sixth pestry, the unicorn appears twice -as being killed, and as the dead nimal being brought to the castle. urprisingly, the alicorn gyre is nown differently in the same animal the two stages. Such an error inattention to detail nevertheless curs even in scientific publications. s for example, in volume 12, page 55 of Wildlife Encyclopaedia, a olour photograph depicts two nar-

whals. Unfortunately, by the carelessness of the block-maker and inaccurate proof-reading, the picture appears reversed, resulting in a serious factual error on the handedness of the narwhal's tusk.

The modern 'unicorn'

Franklin Dove at the University of Maine succeeded in creating an artificial 'unicorn' of an Ayrshire bull soon after its birth in 1933. When it grew up, this unique animal

was equipped with a single lar horn growing out of its forehea (Fig. 5). This was the first tin has been successful man producing an animal resembling somewhat the legendary unicor Dove demonstrated that grafts skin from the horn region, with without the underlying bone, cou give rise to horns in ectopic location He made it possible to produce ext horns by surgically subdividing hor buds and grafting the parts to sep rate regions of the head. Conversel he fused the two horn buds togeth in the middle of the frontal bone : as to develop into a single hornman-made alicorn. Somewh similar results with antlers we achieved by Zbigniew Jaczewski Poland. By cutting off the growing tips of antler buds in fallow deer ar red deer, and transplanting them the middle of the head between the eyes, he was able to create de bearing three antlers each. Th third antler also had the annu cycle of shedding and regeneration as the normal ones.

T. ANTONY DAV

Prof-in-charg

Bio-Science Division

Indian Statistical Institut

Calcutta-7000

Thymus plays a vital role in our body

Our body has some important endocrine glands which secrete organic substances called hormones. These glands via their secretory products play a vital role in regulating the metabolic activity of our body. Thymus is one such important gland but it differs from other endocrine

glands in that it develops and functions in our body only from birt to puberty. In the later stage thymus completely atrophies an ceases to function, whereas othe endocrine glands continue to function from birth till death. A few year ago our knowledge of the function of the thymus gland was limited. Only recently we have come to know to lot about the functions of this important gland.

This unique gland produces and tores for the body a special type of ells called lymphocytes. Quite amaingly, the thymus completes its task it a very early stage or life. This eculiar behaviour of the thymus has urprised immunologists. Even ten ears ago the principle function of his lymphoid organ was not known. lowever, now it is known that hymus controls the maturation and naintenance of a particular part of he lymphoid system which is resconsible for cell-mediated immunoogical reactions, i.e., immunological eactions that are mediated by lymshocytes and not by the antibody of

Historical development

he serum.

The history of thymus dates back to 1899 when an accurate picture of the gland was presented in relation to the functional significance of thymus based on purely histological studies. It was not until the last decade that the contention that thymus was intimately involved with lymphopoiesis received experimental confirmation. It was in 1961 that Jacques F.A.P. Miller, a young Australian cancer research worker at the Chester Beatty Research Institure in London, took up the studies on neonatal thymectomy (removal of thymus after birth). He took great pains in taking out the whole thymus from anesthetized one day old mouse without doing other damages. The results were encouraging when he found that thymectomized (thymus removed) mice had a greater capacity to retain skin homografts in comparison to normal mice. Almost at the same time Carlos Martinex of the University of Minnesota reported similar results. These observations together with many other findings

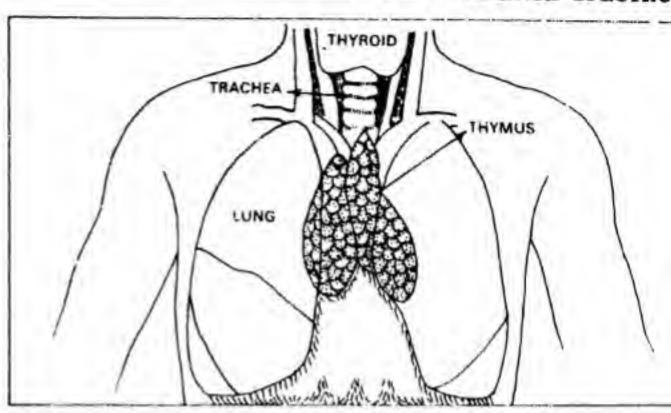


Fig. 1. Location of thymus in human body

which set the stage for a better understanding of the functional role of thymus.

Location in the body

Thymus is a large organ which in man comprises 0.8% of the body weight at birth. In a child it looks like two roughly oval lobes that lie in the front of the chest just behind the top of the breast bone and in front of the aorta (Fig.1). increases in size proportionately with the general growth of the body. At puberty it stops growing and then begins to atrophy. This process of involution occurs in all animals including man. In adults, the actual substance of the thymus is often difficult to distinguish from the fat in which it is embedded. Chicken thymus is composed of 14 separate lobes, seven of which are strung out along each side of bird's neck. The chicken has another organ called the Bursa of Fabricius which is active in the early life and later disappears. The Bursa seems to share with the chicken thymus some of the functions performed in the human by the thymus alone.

Structure

Microscopically thymus contains

the medulla. The cortex is dense packed with lymphocytes which sho a high rate of mitosis and cell deal. The medulla contains relatively few lymphocytes but the epithelial ce are more prominent. There in to medulla are also myoid cells and differentiated epithelial structure called Hassall's corpuscles. Further more, cortex, rich in lymphocyte also contains high amount of DN (Deoxyribonucleic acid). This is to reason why thymus is said to be to best source of DNA.

Functions

Thymus is a compound org consisting of both epithelial (end crine) and lymphoid (immunologic components. The main functions the gland are:

- Differentiation of haemopoie stem cells (immature bone marr cells),
- 2. Induction of immunologi
- Secretion of thymic hormo that regulate the process of differ tiation (maturation of thymus derilymphocytes), and
- 4. Exerts effect on neuromuscultransmission (information transfrom one nerve cell to the other).

It is now realized that the thyr

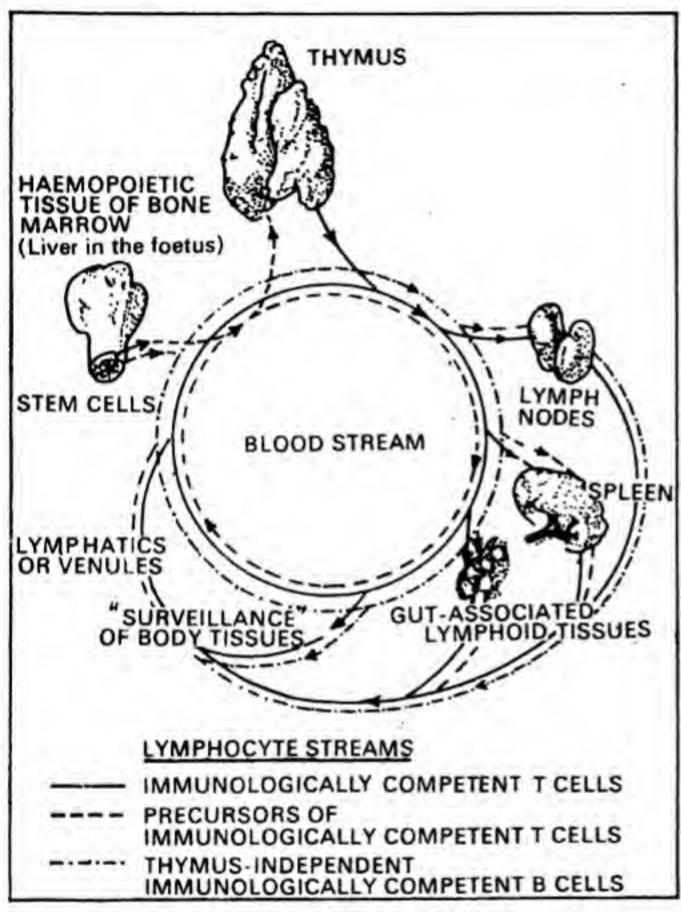


Fig. 2. Circulation of lymphocytes in the body

of cellular immunity, an imporant body defence mechanism that looks after the integrity and ecurity of the body. Thomus is the primary source of lymphocytes in mammals, which when released into circulation after maturation, tettle down in organs such as lymph modes and spleen.

mmunological functions

Experiments on neonatal thymecomy in mice were found to produce mmunological impairments which revealed the immunological function of this gland. The function of thymus in relation to immunity may be broadly stated as the production of thymus-derived cells (lymphocytes) which are called "T cells". These T cells form a large proportion of the pool of recirculating small lymphocytes (there is a depletion of the circulating pool of small lymphocytes on thymectomy). The T cells have immunological specificity and are directly involved in cell-mediated immune response (e.g., homograft response) as "effector cells". It is to

be noted that T cells themselves not form antibodies. Antibodies formed by cells directly derived fr the bone marrow, which do come under the influence of thym these cells are termed as "B cell A close co-operation does exist b ween T and B cells in recognis certain antigens, as some of the cells require the presence of app priate reactive T cells. Fig. shows the circulation of lymphocy in the body. Stem cells arise in bone marrow and reach the thyn via the blood stream. Within thymus, stem cells become different tiated to immunologically compete T cells, emigrate to the blood stream and together with the B cells circula between the tissue lymphatics a the blood stream.

Endocrinological functions

Thymus secretes more than of hormone but in contrast to me other endocrine glands the physical logical site of action of thymhormone (s) is probably local, i.e., thormone (s) acts on the cells differentiating within the thymus itself. The thymic hormone termed as "Thymic is presently being studied by ProG. Goldstein of the New University School of Medicine. It has be found to be basically charged to polypeptides with a molecular weight of 7,000. This material has not you been completely purified.

The exact molecular mechanis of the differentiation of bone marrostem cells within the thymus, und the influence of thymic hormone (is not yet clear. However, experiments on thymic extract and thymimplants (a fragment of the thymitransplanted in the abdominal cavit have contributed a lot towards undestanding the total process of differentiation as summarized in Fig. 3.

More recently (1971), Abraha White and his associates at the A bert Einstein College of Medicine New York have isolated and partially purified a soluble factor known as "thymosin", from calf thymus which when given to normal mice increases the lymphocyte production. Thymosin also accelerates lymphoid tissue regeneration in mice exposed to wholebody X-ray irradiation. In meonatal thymectomized mice, thymosin restores immunological competence of the spleen cells.

Neuromuscular functions

Our knowledge of the neuromuscular functions of the thymus has come from a rare human disease, Myasthenia gravis, a Latin name which means "severe weakness of some or all the muscles." In the 1930's this disease was treated by complete surgical removal of thymus. Thymic abnormality was ong recognized to be associated with Myasthenia gravis. But despite early speculation that the thymus secreted a substance which regulates neuromuscular transmission (information transfer from one neurone to the other), the experimental attempts to demonstrate such a substance are inconclusive. Fig. 4 summarizes the neuromuscular function of thymus. Thymin, a poly-

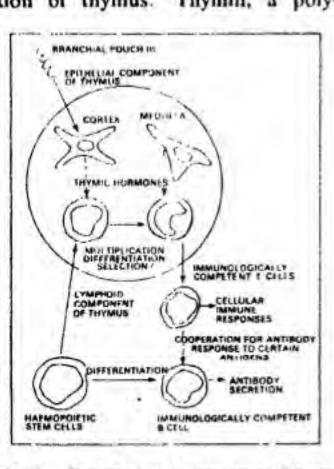


Fig. 3. Summary of the process of differenflation

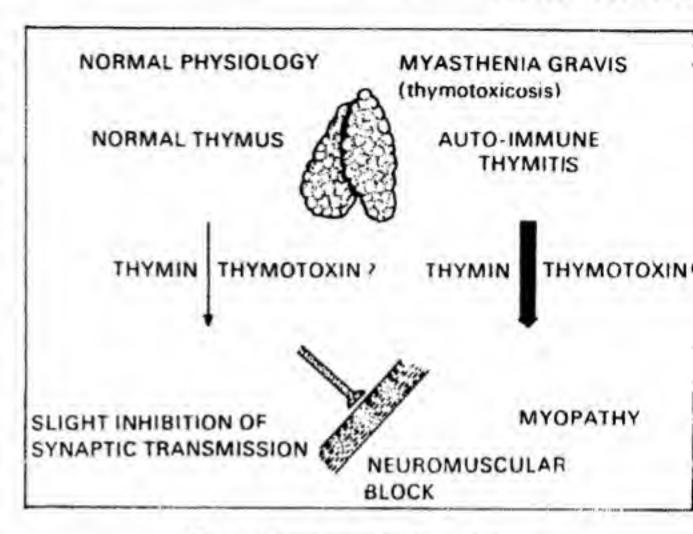


Fig. 4. Neuromuscular functions of thymus

peptide secreted normally by thymic epithelial cells, is secreted in excess in Autoimmune thymitis (inflammation of the thymus leading to an immunological diseased condition) and produces myasthenic neuromuscular block, i.e., block of information transfer from one nerve cell to the other in Myasthenia gravis. A separate polypeptide termed, thymotoxin, has been detected which causes experimental myositis (experimentally induced inflammatory disease of muscle) and may cause Myasthenia gravis.

The measurement of the serum levels of these polypeptide hormones

will have application in relation the study of the neuromuscular trainmission in addition to the treatment of this muscular disorder. Further more, the isolation of the thymhormones will be of utmost importance both from the theoretical standard point and also with respect to the therapeutic utilization in manipulating the immune response in relation to human disease.

SANDIP N. SINI DIPAK K. DU Deptt. of Biochemist Univ. College of Scien Calcutta Universi

Diet for athletes

THE nature of diet has a marked effect on the limits of human performances. The reason for this is that some energy is required during exercise of the muscles and this energy

necessarily comes from diet. A mi weighing 70 kg consumes about 100 Kcal (kilo calorie, the unit energy measurement, which is dened as the amount of heat necessar raise the temperature of 1 litre f water from 15°C to 16°C) energy walk a distance of 2 km. Obviusly, the more his energy storage ne greater will be his ability to talk. Amounts of energy consumed uring some common sports is given a Table 1.

The question what an athlete nould preferably eat to improve his nergy reserve and subsequently his erformance is as old as the history f organized sports itself. The reeks in 5th century B.C. used take meat in large quantities to ake up the supposed loss in muse substances after sport events. ince then' different methods have en in practice from time to time increase one's performance in 19th century orts. In astic measures as fluid restrictions, ood letting and the use of laxaves, were used by some sportsmen. byiously, these methods were far om being beneficial. With the scovery of vitamins and protein blets, it has been observed that ese drugs and medicines have a mporary effect on the athlete, wheas a regular good diet has a pronged effect on body.

able 1. Energy consumed in some numon sports (base metabolic rate of an is 0.59 calorie per minute per uare meter of surface area)

ports	Energy consumed (in cal/ per minute/meter ²)
erman e e e e	
otball	5.01
sket ball	4.31
wling	4.06
imming	6.06
ar a	2.76
nnis	3,50
ble tennis	2.00
dminton	1.91
wing	4.00
ling	1.30
ling	1.50
king	5.00
lking (outdoo	or) 3.07

Fuel for working muscle

If protein is used only to a negligible extent so long as the caloric supply is adequate, the choice for a fuel for the working muscle automatically falls either on fat or on carbohydrate. Fat contains as much as 90% carbon and hydrogen and has an energy density of 9 Kcal per gram, whereas carbohydrate contains only 46% carbon and hydrogen and has an energy density 4 Kcal per gram. Moreover, carbohydrate is stored with a large quantity of water (in mammals 2.7 gm per gm of dried glycogen). This reduces the energy density of glycogen to about 1 Kcal/gm, whereas the caloric value of adipose tissue (which does not consist of pure fat) is 6 Kcal/gm to 7 Kcal/gm. Thus fat is a far better storage of energy.

The migratory birds and fishes (like eels and salmons) also have their energy for migration mainly stored in fat. This is purely an evolutionary adaptation because the weight of carbohydrate (if stored as the source of energy) won't be sufficient to allow it to fly more than a few hours.

However, most mammals, including man, depend on both fats and carbohydrates for their muscle metabolism. Experiments with human subjects have shown that in man with a body weight of 75 kg the available energy bound in adenosine triphosphate (ATP) is about 1.2 Kcal, in creatine phosphate 3.6 Kcal, in glycogen 1200 Kcal and in fat about 50,000 Kcal, with aerobic energy as 15-20 Kcal per minute or more.

Energy of working muscle

In the fourth decade of this century, some classic experiments were made on the metabolism of muscles during physical work. The results of these experiments showed that fat supplied about 50%-60% of energy when the

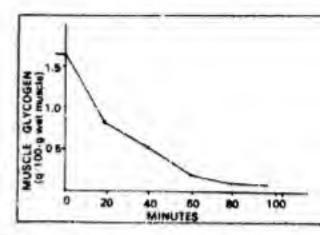


Fig. 1. The glycogen content of quadceps fermoris muscles before a after exercise

subjects were fed on normal mixed diet and engaged in essentially aero bic exercise but when the work we heavy the carbohydrate supplied the greater part of the energy.

Recent experiments on exercisin human muscle quadriceps femor by biopsy (biopsy-examination of living tissues; Gk: bios means lif and opsis means sight) technique shows that the energy for working o these muscles is supplied by the com bustion of glycogen. On a norma diet the quadriceps femoris muscl contains glycogen between 1.0 gr per 100 gm to 2.0 gm per 100 gr wet muscle (muscle weighing 100 gr including its water content). Experi ments after exercise of the muscl show that the glycogen reserve de creases to a level of 0.1 gm per 100 gm wet muscle and the subject is eithe to stop work or to slow down th speed to a rate at which the oxida tion of free fatty acid can generate the necessary energy (Fig. 1).

Many similar experiments suggest that the initial glycogen content of skeletal muscle is of decisive importance for an individual's capacity to sustain prolonged heavy exercise. This led people to find out to what extent the diet can modify the glycogen content of muscles.

The results of another set of experiments done recently show that a subject taking normal mixed die accumulates a glycogen content of 1.75 gm per 100 gm wet muscle and can withstand a standard workload equiring an average of 75% of the naximum oxygen uptake for 114 ninutes. When the subject spends aree days on a very high fat and rotein rich diet, the glycogen conentration comes down to 0.6 gm er 100 gm wet muscle and the stanard workload can be performed nly for 60 minutes. However, if he same subject is fed for three days n carbohydrate rich diet, the glycoen content rises to 3.5 gm per 100 m wet muscle and the standard orkload can be tolerated for about 70 minutes. But, the most proounced effect is obtained if the glyogen content is first consumed by igorous prolonged exercise with a w carbohydrate diet for three days nd then boosting it up by rich arbohydrate diet. In this way ne glycogen contents can be raised 4 gm per 100 gm wet muscle nd heavy workload can be tolerad for a much longer period.

Therefore, in preparing stamina of ong duration the athelete should chaust all the glycogen reserve in is muscles before a week of the event y heavy exercise. Then, for next aree days he should take diet rich protein and fat to keep the glycoen content low. In the last three four days before the event he hould take carbohydrate-rich food get best result. In fact this easure has been taken by Olympic juads of many countries, mounineers and even by army men for rolonged operation. However, the reatest drawback with glycogen is s high water content. In mammals 7 gm of water is stored with every am of glycogen stored, this means at when 700 gm glycogen is stored e weight of body water increases 2 kg.

aintenance of blood sugar level tring exercise

Though glycogen is the main ergy source, only the glycogen reserves of the working muscles are consumed. The glycogen reserves of liver remain unaffected. The liver contains 50 gm to 100 gm of glycogen which acts as a store of carbohydrate to maintain the blood glucose level. It supplies glucose to the central nervous tissue which has no carbohydrate reserve of its own. If this blood sugar enters the muscle cells during exercise it will be consumed at the expense of central nervous system causing a serious threat to the subject.

With a blood sugar level of 100 mg/100 ml and a blood volume of 5 litres to 6 litres (average figures), the total glucose circulating in the blood is 5 gm to 6 gm. But as much as 3 gm of carbohydrate is lost during every minute of heavy exercise and in this way the blood glucose will last only for two minutes. But this is prevented by the system in two different ways.

Optimal diets

Except in some cases like growing children, pregnant women and some convalescent patients caloric intake should not exceed caloric expenditure. Moreover, we all know that a person's caloric requirements vary according to his physical activity, but his need of nutrients is quite independent of his activities. That is why a sedentary person's (who is essentially a low calorie consumer) diet must contain more essential nutrient per calorie than an active person's (high calorie consu-

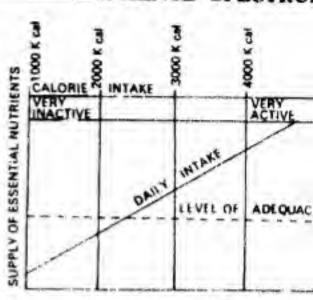


Fig. 2. The relationship between the tot caloric intake and the supply nutrients

mer). As such a dietary pattern wir a linear relationship between the supply of calories and supply of man nutrients (protein, calcium, vitamin iron, etc.) should be developed (Fig. 2).

Through centuries human being have been used to a daily output of 3000 Keal or more, a choice the provides all nutrients required. In deed, to supply all the nutrients required the caloric intake must excee 2500 Keal. In fact, our society has a large proportion of low-calor consumers and their representation in sports events is very low, comparative chart of sportsmen from different calorie consumer group and the points obtained by them in Olympic games (1952) is given in Table 2.

There are two basic ways in which the nutritional status of low-calor consumers can be improved. Firstly change in their food habits, so that their diet has a higher content of essential nutrient per calorie

Table 2. Olympic (1952) participation and achievements of sportsmen from different caloric consumption group

Kcal per day per head	Population in millions	Participation	Participation rate	Points
1500-1999	432	40	0.09	610
2000-2499	749	397	0.53	8709
2500-2999	82	264	3.24	5936
3000-3499	232	969	4.17	29324

to raise the temperature of 1 litre of water from 15°C to 16°C) energy to walk a distance of 2 km. Obviously, the more his energy storage the greater will be his ability to walk. Amounts of energy consumed during some common sports is given in Table I.

The question what an athlete should preferably eat to improve his energy reserve and subsequently his performance is as old as the history of organized sports itself. The Greeks in 5th century B.C. used to take meat in large quantities to make up the supposed loss in muscle substances after sport events. Since then' different methods have been in practice from time to time to increase one's performance in 19th century A.D., sports. In drastic measures as fluid restrictions, blood letting and the use of laxatives, were used by some sportsmen. Obviously, these methods were far from being beneficial. With the discovery of vitamins and protein tablets, it has been observed that these drugs and medicines have a temporary effect on the athlete, whereas a regular good diet has a prolonged effect on body.

Table 1. Energy consumed in some common sports (base metabolic rate of man is 0.59 calorie per minute per square meter of surface area)

Sports	Energy consumed (in cal, per minute/meter ²)
Cauthall	5.01
Football	4.31
Basket ball	4.06
Bowling Swimming	6.06
Golf	2.76
Tennis	3.50
Table tennis	2.00
Badminton	1.91
Rowing	4.00
Sailing	1.30
Riding	1 50
Hoxing	5.00
Walking (outdo	or) 3.07

Fuel for working muscle

If protein is used only to a negligible extent so long as the caloric supply is adequate, the choice for a fuel for the working muscle automatically falls either on fat or on carbohydrate. Fat contains as much as 90% carbon and hydrogen and has an energy density of 9 Kcal per gram, whereas carbohydrate contains only 46% carbon and hydrogen and has an energy density 4 Kcal per gram. Moreover, carbohydrate is stored with a large quantity of water (in mammals 2.7 gm per gm of dried glycogen). This reduces the energy density of glycogen to about 1 Kcal/gm, whereas the caloric value of adipose tissue (which does not consist of pure fat) is 6 Kcal/gm to 7 Kcal/gm. Thus fat is a far better storage of energy.

The migratory birds and fishes (like eels and salmons) also have their energy for migration mainly stored in fat. This is purely an evolutionary adaptation because the weight of carbohydrate (if stored as the source of energy) won't be sufficient to allow it to fly more than a few hours.

However, most mammals, including man, depend on both fats and carbohydrates for their muscle metabolism. Experiments with human subjects have shown that in man with a body weight of 75 kg the available energy bound in adenosine triphosphate (ATP) is about 1.2 Kcal, in creatine phosphate 3.6 Kcal, in glycogen 1200 Kcal and in fat about 50,000 Kcal, with aerobic energy as 15-20 Kcal per minute or more.

Energy of working muscle

in the fourth decade of this century, some classic experiments were made on the metabolism of muscles during physical work. The results of these experiments showed that fat supplied about 50%-60% of energy when the

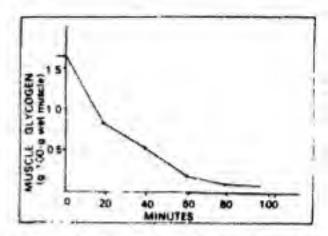


Fig. 1. The glycogen content of quadriceps fermoris muscles before and after exercise

subjects were fed on normal mixed diet and engaged in essentially aerobic exercise but when the work was heavy the carbohydrate supplied the greater part of the energy.

Recent experiments on exercising human muscle quadriceps femoris by biopsy (biopsy-examination of living tissues; Gk: bios means life and opsis means sight) technique shows that the energy for working of these muscles is supplied by the combustion of glycogen. On a normal diet the quadriceps femoris muscle contains glycogen between 1.0 gm per 100 gm to 2.0 gm per 100 gm wet muscle (muscle weighing 100 gm including its water content). Experiments after exercise of the muscle show that the glycogen reserve decreases to a level of 0.1 gm per 100 gm wet muscle and the subject is either to stop work or to slow down the speed to a rate at which the oxidation of free fatty acid can generate the necessary energy (Fig. 1).

Many similar experiments suggest that the initial glycogen content of skeletal muscle is of decisive importance for an individual's capacity to sustain prolonged heavy exercise. This led people to find out to what extent the diet can modify the glycogen content of muscles.

The results of another set of experiments done recently show that a subject taking normal mixed diet accumulates a glycogen content of 1.75 gm per 100 gm wet muscle and can withstand a standard workload equiring an average of 75% of the naximum oxygen uptake for 114 ninutes. When the subject spends hree days on a very high fat and protein rich diet, the glycogen concentration comes down to 0.6 gm er 100 gm wet muscle and the stanlard workload can be performed only for 60 minutes. However, if he same subject is fed for three days on carbohydrate rich diet, the glycoen content rises to 3.5 gm per 100 m wet muscle and the standard vorkload can be tolerated for about 70 minutes. But, the most proounced effect is obtained if the glyogen content is first consumed by igorous prolonged exercise with a ow carbohydrate diet for three days nd then boosting it up by rich arbohydrate diet. In this way he glycogen contents can be raised o 4 gm per 100 gm wet muscle nd heavy workload can be toleraed for a much longer period.

Therefore, in preparing stamina of ong duration the athelete should xhaust all the glycogen reserve in is muscles before a week of the event y heavy exercise. Then, for next hree days he should take diet rich a protein and fat to keep the glycoen content low. In the last three r four days before the event he hould take carbohydrate-rich food o get best result. In fact this neasure has been taken by Olympic quads of many countries, mounaineers and even by army men for rolonged operation. However, the reatest drawback with glycogen is s high water content. In mammals .7 gm of water is stored with every ram of glycogen stored, this means hat when 700 gm glycogen is stored he weight of body water increases y 2 kg.

faintenance of blood sugar level uring exercise

Though glycogen is the main nergy source, only the glycogen reserves of the working muscles are consumed. The glycogen reserves of liver remain unaffected. The liver contains 50 gm to 100 gm of glycogen which acts as a store of carbohydrate to maintain the blood glucose level. It supplies glucose to the central nervous tissue which has no carbohydrate reserve of its own. If this blood sugar enters the muscle cells during exercise it will be consumed at the expense of central nervous system causing a serious threat to the subject.

With a blood sugar level of 100 mg/100 ml and a blood volume of 5 litres to 6 litres (average figures), the total glucose circulating in the blood is 5 gm to 6 gm. But as much as 3 gm of carbohydrate is lost during every minute of heavy exercise and in this way the blood glucose will last only for two minutes. But this is prevented by the system in two different ways.

Optimal diets

Except in some cases like growing children, pregnant women and some convalescent patients caloric intake should not exceed caloric expenditure. Moreover, we all know that a person's caloric requirements vary according to his physical activity, but his need of nutrients is quite independent of his activities. That is why a sedentary person's (who is essentially a low caloric consumer) diet must contain more essential nutrient per calorie than an active person's (high calorie consu-

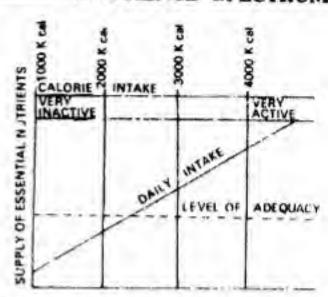


Fig. 2. The relationship between the total caloric intake and the supply of nutrients

mer). As such a dietury pattern with a linear relationship between the supply of calories and supply of many nutrients (protein, calcium, vitamins, iron, etc.) should be developed (Fig. 2).

Through centuries human beings have been used to a daily output of 3000 Kcal or more, a choice that provides all nutrients required. Indeed, to supply all the nutrients required the caloric intake must exceed 2500 Kcal. In fact, our society has a large proportion of low-calorie consumers and their representation in sports events is very low. A comparative chart of sportsmen from different calorie consumer groups and the points obtained by them in Olympic games (1952) is given in Table 2.

There are two basic ways in which the nutritional status of low-calorie consumers can be improved. Firstly, change in their food habits, so that their diet has a higher content of essential nutrient per calorie.

Table 2. Olympic (1952) participation and achievements of sportsmen from different caloric consumption group

Kcal per day per head	Population in millions	Participation	Participation rate	Points
1500-1999	432	40	0.09	610
2000-2499	749	397	0.53	8709
2500-2999	82	264	3.24	5936
3000-3499	232	969	4.17	29324

Secondly, low-calorie consumers should be changed into high calorie consumers by persuading them to take part in regular physical exercises.

The athletes are high energy consumers. They should have a surplus of all nutrients including proteins. So, except for a few days immediately before an endurance event, they should stick to normal meals.

AMITABH HORE

Liver detoxicates drugs

WE inhale, ingest and come in contact with a variety of chemicals in our day to day life. In the process we not only enjoy the gifts of nature in the form of oxygen, water and food but are also exposed . to undesirable products-result of human activities-the pollutants in air, water and food, deliberately introduced adulterants, food additives, drugs, tobacco smoke and accidental poisons. However, to deal with many of these chemicals (exogenous) and those harmful substances formed within the body (endogenous) there are built-in mechanisms in the body to help body resist the harmful effects or metabolise these substances into harmless ones and excrete them through excretory system of the body. The role of liver in such detoxification activities is the foremost.

Functions

Liver is the largest body organ (about three pounds) with many and diverse functions. Primarily it acts as a depot to receive all that has been absorbed by the intestine, the absorbed substances reach liver through the portal vein which ramifies and distributes portal blood to liver cells. In liver cells nutrients and other foreign substances are metabolised. Some substances are first stored in the liver and then released

on need. For example, aminoacids are converted into proteins and
other nitrogenous compounds; glucose is converted into glycogen
which can be converted back into
glucose, and released as and when
required. Drugs and other substances are transformed or converted
into harmless substances and excreted out. The mechanism of this
biotransformation assumes much
significance in medicine and toxicology.

Biotransformation in liver

Liver is the only organ in the body where maximum number of chemical reactions takes place. However, biotransformations of certain drugs or substances may also occur in other body tissues and organs such as intestine, kidney and skin.

In general, biotransformations of drugs and other foreign substances in liver involve several remarkable enzyme systems that can metabolise a wide variety of structurally unrelated drugs, toxic agents, and environmental pollutants which enter the body by ingestion, inhalation or skin absorption, mainly through the former.

Enzyme systems

The enzyme systems for biotransformation are built into the membranes of endoplasmic reticulum (ERC) of the liver cells. This reticulum, constituted of a network of interconnected channels, is of two types: rough and smooth. The smooth surface ERC is devoid of ribosomes whereas the rough surface ERC is studded with ribosomes on its surfaces. In liver, both types of ERC, smooth and rough, assemble the enzymatic complexes required for transformation of foreign substances. They serve as the site for those biotransformations.

Drugs and other foreign chemicals in the liver undergo reactions of oxidation, reduction, hydrolysis and conjugation. A majority of biotransformations essentially involve conversion of lipophilic or fat soluble compounds into hydrophilic or water soluble compounds. The latter are rapidly removed from the blood by the kidney.

The oxidation reactions account for most of the conversions. Reduction and hydrolyses are also catalysed by liver enzymes but these reactions are less common than oxidation. Conjugation takes place by combination of the compound with a natural constituent of the body such as the glucose derivative glucuronic scid, the amino acid glycine or the tripeptide glutathione. These natural agents combine with the carboxyl (COOH), sulphydryl (SH), amino (NH₂) or hydroxyl (OH) groups of compounds (to be conjugated) in the presence of the appropriate enzyme (Scientific American, June 1975). The conjugation takes place: (i) to render the compound or drug pharmacologically or biologically inactive, and (ii) as a secondary step (after the usual processes of oxidation, reduction, or hydrolysis) for excretion of such compounds.

Howard. S. Mason of the University of Oregon Medical School in 1957 proposed a class of NADPH (Nicotinamide adenine dinucleotide phosphate-reduced) dependent oxygen requiring enzyme complexes, "mixed function oxidases." The key enzyme of this system is cytochrome P-450 (cyt. P-450), named so because in the reduced form it binds carbon monoxide (CO) and then absorbs light most intensely at a wavelength of 450 nanometers. The amplitude of the absorbance peak is also the basis of its quantitative measurement. Cyt P-450 is the terminal oxidase of the system, i.e., it accepts electrons passed on along several intermediates. It then binds oxygen and delivers it to oxidise its substrate and usually produce water.

Drug therapy

If a drug somehow could stay in the body unchanged it would continue to act indefinitely. But drugs are metabolised by the liver and converted into inactive substances and excreted out of the body. Bio-conversion of drugs does not take place in one but in several steps; with each blood circulation a part of the drug is converted whereas the rest is left unaltered. The active form of the drug (unconverted drug) in the meanwhile acts on the target organ or tissue to bring about the desired effect. So before prescribing a dose it is desirable to take into account the rate of metabolism of the drug by liver and make sure that enough of it will persist in the desired concentration during the required period of therapy.

Age

Human foetus and newborn infants are specially more sensitive to certain drugs. The sensitivity is mainly due to inefficient drug metabolism. The capacity to oxide and conjugate drug increases with age and varies from species to species depending on the drug. It is well known that barbiturates or morphine given to a woman during child birth may lead to tissue saturation of the infant with these drugs causing respiratory depression and even death. Antibiotic therapy is generally not advisable to infants. Administration of the antibiotic chloramphenical soon leads to "grey baby syndrome": the symptoms are abdominal distention, respiratory difficulty, cyanosis (blue skin colour as a result of insufficient oxygenation of the blood) and shock.

Individual variations

The rate of drug metabolism varies in different species as well as in individuals of the same species. In some patients a drug may be metabolised so rapidly that it becomes difficult to achieve therapeutically effective blood and tissue levels in them. On the other hand, some individuals metabolise drugs so showing that they suffer from toxic effects. As a result, it is sometimes difficult for a physician to prescribe a safe and therapeutically effective dose to his patients.

Drug interactions

The action of even the most commonly used drugs at the cellular and molecular levels is not well understood. And when many drugs are given at a time it becomes difficult to know which drug is causing adverse effects. Sometimes inhibitory action of these drugs on drug metabolizing enzymes or the chemical interactions among the drugs itself may lead to unpredictable and often undesirable effects.

Pollutants affect drug therapy

Many environmental pollutants are known to induce or inhibit the microsomal enzyme system in liver or other body tissues. DDT and other insecticides such as chlordane, aldrin, and dieldrin induce microsomal enzymes. DDT is also known to act (synergestically) with some drugs

to induce the microsomal enzymes synthesis. The polychlorinated biphenyls (PCB's) used in lubricants. insulators, plasticizers (for paints), plastic compound and microscope lens immersion oil are known to induce microsomal enzymes. All these inducers of microsomal enzymes may therefore affect drug therapy. A small quantity of DDT in human (10 to 15 micrograms per gram of fat) is enough to metabolize pentobarbital and reduce its hypnotic effects. Similarly, other environmental pollutants may induce the drug metabolising system and render either drug therapy ineffective or lead to adverse drug reactions.

The heavy metals such as lead and mercury inhibit the microsomal enzymes and adversely affect drug metabolism. The inhibitory action of heavy metals, though otherwise important for general population exposed to various metals in the polluted air, water and food, is grave for those who are occupationally exposed to fairly high concentrations of such metals in mining and industries. The effects of industrial toxins on the drug metabolizing enzyme systems of the workers, exposed to varied toxins in various industries, are not yet understood. Patients with a history of occupational exposure to any class of industrial toxins, therefore, need to be cautiously dealt with by the physician while prescribing a drug.

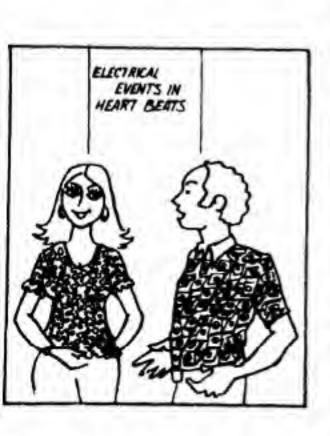
ZAKA IMAM

Electrical events in the origin of heart beats

THE fact that vertebrate heart has a built-in device to regulate its own beating pattern was known even to the Alexandrian anatomist.

Erasistratus, in the third century B.C. In 1882, English physiologist, Sydney Ringer, showed that the heart of frog, if continuously washed with a solution containing salts of sodium, potassium and calcium, and glucose, continued to beat even when removed from the body. What causes the heart to beat so precisely 104,000 times a day (in man), 2,200,000,000 times during a life-time of 60 years, and pumping nearly 335,000 tons of blood!

The inherent power of rhythmic contraction of heart resides in a barely discernible area of specialized cardiac tissue in the wall of right auricle, called the sinu-auricular node. Another mass of specialized cells is situated in the right posterior portion of interventricular septum, and is called as auriculo-ventricular node. Together, these may be called as pacemakers' of the heart, for they set the pace at which the heart beats. innervated by nerve Heart 18 components from autonomic nervous system which can modify the heart heat, and by the vagus nerve whose stimulation inhibits the heart beat. However, the pacemakers do



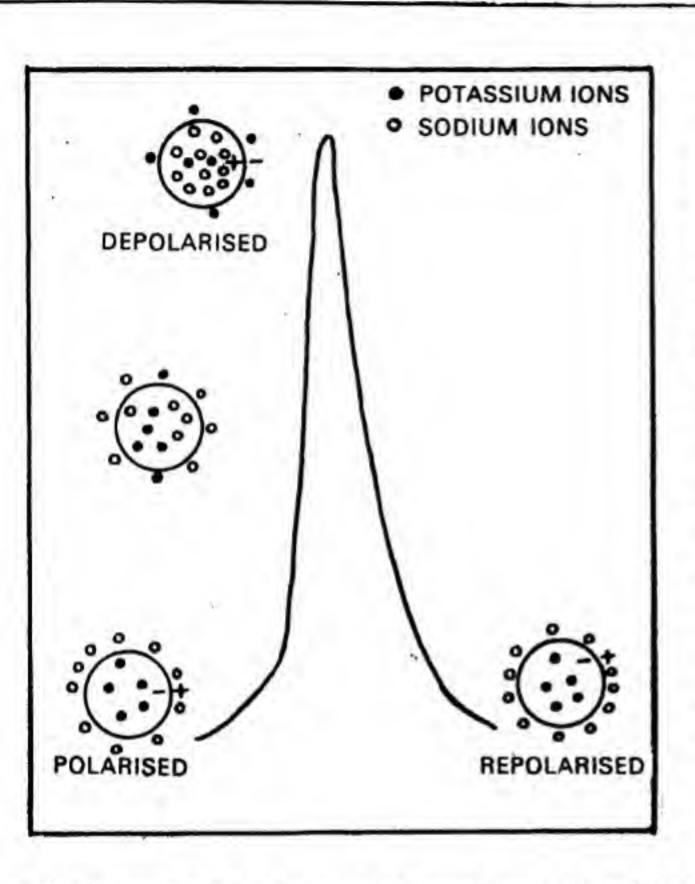
That explains why I feel electrified heart when I meet you."

not depend upon the nerves for their activity.

The wave of excitation is initiated in the sinu-auricular node and while spreading through the wall of atria stimulates the auriculo-ventricular node. From auriculo-ventricular no de the wave of excitation passes to the bundle of His and Purkinje fibres causing ventricular contraction. How the wave of excitation originates in the sinu-auricular node? The physiological role of sodium, potassium and the calcium ions soon becomes apparent in generating an electrical impulse in the cells of sinu-auricular node. At rest, the pacemaker cells are said to be polarised, i.e, the inside is negative with respect to outside which is positive. This is due to the predominance of sodium ions outside the cells which outnumber the potassium ions inside the cells of pacemakers. The potential difference is about 1/10 volt. The plasma membrane of pacemaker cells is partly permeable to the sodium ions so that these ions continuously infiltrate the cells with a resultant decrease in the potential difference between outside and inside of the cell. When the potential difference is reduced to about 1/600th of a volt, the sodium ions rush in quickly while some of the potassium ions escape outside. This leads to a reversal of electrical charges on the two sides of the membrane of pacemaker cell so that the inside now becomes positive with respect to outside. This sudden depolarisation is the origin of electrical spark which triggers similar events in the adjacent cells and the consequent wave of excitation. The depolarised cells soon repolarise by becoming negative inside and positive outside the plasma membrane. This is achieved by pumping out the sodium ions which had infiltrated earlier. Since, the sodium concentration is already higher outside the cells, they have to be acti-

vely transported with expenditure of energy supplied by ATP. This is why the cardiac tissue has a high demand for oxygen and the nutrient glucose for regeneration of ATP to sustain the activity. The electrical impulse generated, spreads to adjacent cells by a kind of relay system so that the intensity of impulse does not decrease with the distance travelled. When the electrical impulse reaches the cardiac muscle fibre, it triggers the breakdown of ATP and contraction of the fibres. A concerted effort causes the rhythmic contraction of the auricles and then of the ventricles. The impulse is delayed for a moment before exciting the auriculo-ventricular node, so that the auricular contraction is complete prior to the commencement of the ventricular contraction. Such electrical events occurring in the heart can be recorded on a paper, electrocardiogram, which reflects the activity of the various parts of the heart and thus aids in diagnosis of different heart ailments.

The rate at which electrical sparks are discharged depends upon two factors; (1) rate of infiltration of sodium ions into pacemaker cells, and (2) the extent to which the potential difference must be reduced to facilitate depolarisation. The permeability of cell membrane to sodium ions is affected by temperature. It increases with rise in temperature and decreases when the temperature is lowered. A faster rate of heart beat in fever is attributable to this characteristic of the pacemaker cells. The calcium ions are critical for the stability of the cell membrane and too many of them slow the rate of discharges. The heart is slowed by stimulation of the vagus nerve. The underlying mechanism is that the acetylcholine, which is released at the synapse in the vagus nerve, increases the permeability of cell membrane to the



notassium ions so that they pass into the cell increasing their negativity, hyperpolarisation. Under such conditions, the time between two successive depolarisations would be longer and consequently the rate of heart peat slower.

Lack of coordination between the two pacemakers leads to fibrillation. This is characterised by several impulses travelling in different directions causing arrgythmic contractions of different areas of myocardium. The fibrillation of atria is compatible with life but that of ventricles is usually fatal, because of lack of synchrony not enough pressure is developed to pump the blood. Fibrillation of the blood.

rillation may be caused due to lack of oxygen, mechanical stimulation of heart, or strong electrical current passing through the heart.

In the event of the built-in pacemaker going out of order, the artificial pacemakers may be installed. These are designed to send impulses to the heart at a preset rate. But, unlike natural pacemakers, artificial pacemakers fail to respond to bodily needs where an alteration in the rate of heart beat is required.

T.S. GILL

Department of Zoology

DSB College

Naini Tal (U.P.)

Body fatigue

CATIGUE results from strenuous continuous muscular activity and activity of the nervous system (mental work). Frequently, both types-muscular and mentalcombine to cause fatigue. consequence is diminished capacity for work. In muscular exercise fatigue is due to accumulation of metabolic products, the depletion or non-availability of energy yielding substances and other muscular, respiratory and circulatory phenomena. Physical fatigue is of great importance to a physiologist. Accumulation of end products of metabolism becomes a hindrance to vital exchanges of the body like lactic acid, carbon dioxide, acid phosphates and lack of oxygen. Also, an alteration of the physico-chemical state causes fatigue, like chloride losses, excessive sweating, dehydration gastric hyperacidity, acidosis, exhaustion muscular and gastrointestinal cramps. Disturbances of homeostasis (maintenance of internal body environment) cause fatigue. External factors responsible for fatigue are deficient muscle nutrition and resistance to emotional disturbances.

Mental fatigue may be due to anxiety, nervous tension, monotony of the task, noise, vibrations and lack of adequate rest periods. The different seats of fatigue are: (1) muscle fiber, (2) motor nerve and plate in the muscle, (3) motor nerve fiber, (4) synapses (contacts where the long processes of the nerves end in branches which interact with the branches of other nerve cells. These contacts permit impulse transmission) within the nerve ganglia (outside the central nervous system are found collections of nerve cells known as ganglia) and the central nervous system, (5) the nerve cell body, and (6) the effectors-muscles. The different signs of fatigue are: decreased capacity for doing effective work, feeling of tiredness, tired feeling in head, obscure and poorly localised pains in the back of the head, pain and soreness in the muscles, stiffness in the joints and swelling of the hands and feet. Arithmetical calculations are slowed and inaccurate.

The onset of rest can change from one moment to another. This depends upon the physiological condition of the individual. The change takes place in the whole area so that the relative capability to rest of its different paris remains unchanged. However, this relative capacity may be disturbed by 'local fatigue' at a point that has been continually stimulated. The threshold of the rest increases gradually, and the stimulus become: less than minimal. Local fatigue disappears after a few minutes rest. Continued repetitive stimulation for a long time is followed after a time by a progressive decrease in the capacity of the muscle to contract. After a period of rest, the muscle recovers its capacity to respond. In other words it contracts. This may be due to the failure of (a) passage of impulse from nerve to muscle fiber known as transmission fatigue or, (b) the contractile mechanism-contraction fatigue. Transmission fatigue is produced by prolonged stimulation of the motor nerve (nerve going from centre to the muscle) at a sufficiently high frequency (60/sec). At this time direct stimulation shows that there is no loss in the capacity of the muscle to contract or to respond to a stimulus, even when its response to nerve stimulation is considerably reduced. In this fatigue the acetylcholine (a chemical released at the end of a nerve) output/impulse decreases, and the response is improved by acetylcholine or cholinesterase (enzyme) antagonists. If the frequency of the stimulation is low (less than 30/sec).

there will be no transmission fatigue and the progressive fall in the mechanical response (contraction) will be due to contraction fatigue. In this type of fatigue the contraction time of muscle increases. Relaxation time becomes slower and less complete as the fatigue progresses. The extent of an isotonic contraction decreases because shortening of muscle is progressively reduced and the relaxation is incomplete. An isotonic contraction is one when a muscle changes in length under a constant tension. Here the muscle is firmly fixed/attached to one end and the other end of the muscle is free to move; running or lifting is of this type. Here the muscle contracts and does the work. If the load on the muscle is increased, fatigue develops more rapidly. Conversion of chemical energy into tension becomes less efficient. Metabolic products like lactic acid accumulate and their removal from the body hastens the recovery. Energy producing substances like glycogen decrease and fatigue occurs very rapidly. As such the recovery processes are delayed and inhibited. A completely fatigued muscle goes into contracture (fatigue cramp). In maximal voluntary effort of the body as in running, the supply of exygen is the factor which limits the performance (for example: the running activity). Fatigue results due to failure of muscle to contract (contraction fatigue. Maximal voluntary contractions of a single small muscle (adductor of the thumb) are also limited by the blood supply. Fatigue does not seem to be caused by failure of neuromuscular transmission (transfer of impulse from nerve to muscle) because there is no change in action potentials (electrical changes) evoked by maximal electric shocks given to the nerves.

In steady prolonged exercise, fatigue is due to a number of ill-understood factors. In the main it is

attributed to changes in the brain resulting from slight anoxia (want of oxygen) and increased hydrogen ior concentration. Afferent impulses (which send the information to the centre-brain) set up in the active muscles (in part perhaps by the local physico-chemical changes) give rise to discomfort and contribute to the sense of weariness. Some of the stiffness may be due to the swelling of the muscle from accumulation of the fluid which has oozed out from blood. Presumably in this case fatigue occurs owing to changes in the muscles induced by (1) anoxia, (2) accumulation of metabolites. Both these changes are offset by blood flow, but there are mechaproblems in nical maintaining blood flow during sustained contraction. This is because of the rise in intramuscular tension which tends to prevent passage of blood.

High frequency stimulation for a sufficiently long time provokes signs of fatigue in nerves: velocity to conduct nerve impulse decreases and the refractory period (time when a nerve does not respond to a stimulus) increases. Fatigue develops simultaneously along the whole length of the nerve, and recovery takes place at the same rate all along the whole length of the nerve. A certain degree of recovery can take place in condition of anoxia, but in the absence of oxygen fatigue develops more rapidly.

Adrenaline, a chemical-hormone released at certain nerve endings, accelerates recovery after fatigue and increases the twitch tension of non-fatigued striated (skeletal) muscle. This effect is associated with an increase in resting potential and a decrease in the rate of potassium loss from the muscle. In adrenal (endocrine gland) insufficiency, loss of strength (asthenia) and the rapidity of the onset of fatigue take place. Signs of fatigue may be observed

when a stimulus is repeatedly applied, so that it loses its efficiency and fails to evoke a response. This is most evident in widespread and local reflex responses.

The ear is stimulated continuously by sound, but it is remarkable how rapidly it recovers from fatigue. Fatigue lasts for a few seconds or minutes according to the pitch of the tone. High tones produce more prolonged fatigue than low tones. For example, if a sound of 94 db (decibel-unit of noise), the intensity of 2-minute duration has a frequency of 100 cycles, it produces fatigue lasting 20 sec, if the frequency is 4000 cycles, fatiguel asts 6 minutes. There is a centra I factor in fatigue (dependent on the response of the brain centres) which makes the estimation

of fatigue in the receptor difficult.

A given stimulus soon loses its effi-

ciency in the olfactory receptor (re-

ceptor concerned with hearing), especially if it is a strong one. This is due in part to fatigue. Recovery, however, takes place very rapidly. Fatigue produced by one substance diminishes, but does not suppress the effects of others of different odour. If the fatigue is marked, there is a transitory partial anosmia (complete absence of sence of smell) for the substances that have produced fatigue.

Fatigue soon occurs in taste. Persistence of a stimulus decreases the sensitiveness of the taste stimulated. There is some evidence that sensitiveness of the ether taste receptors is simultaneously increased. Fatigue and old age decrease sensitiveness to touch, especially the capacity to distinguish.

P.C. GANGWAR

Dept. of Animal Science

P.A.U., Ludhiana

viable larval stages. Still others enter our body through the skin. Some parasites enter our body through the intermediate host species of the arthropods and others.

Domestic pets, dogs, cats and others may also be sources of parasitic infection to man. These pets sometimes serve as alternate hosts to the parasites of man. In addition, man may serve as a temporary host for the larval stages of the parasite of a pet animal. The development of such larval stages occurs in dogs, cats, etc.

Is your pet infected?

Though the external parasites are easy to observe, it needs a trained eye to identify them. Infested animals become restless, and ruin their coats by biting and scratching. The internal parasites are more difficult to observe. However, one can look for general symptoms such as emaciation, loss of weight, diarrhoea, dysentery or constipation, anaemia, restlessness, etc. The animals may show general unthriftiness, a potbellied appearance or the tucked up abdomen. Itching of the skin and areas of dermatitis, caused by the larvae of the hookworms, are also observed. In tapeworm infections, gravid segments are usually seen in the faeces. Sometimes, these segments may migrate to the anus attaching themselves to the surrounding hair.

Pets can be dangerous

PARASITISM is a common feature of animal life; there are more parasites than free living animals. Parasites give rise to many infectious diseases in men and animals and can even cause death of the host. There are a large number of parasites which are shared by man and his pet animals. The health problems arising out of close manpets' association need consideration because pets are a source of infection in man.

Animal parasites

Most animal parasites belong to three large divisions of the animal kingdom—the protozoans or onecelled organisms; the helminths (roundworms, flukes, tapeworms and spiny-headed worms) or parasitic worms; and the arthropods or invertebrate species with articulated appendages.

How do parasites enter our body? The first step to end parasitic sufferings is to find out how parasites gain access to our body. They enter our body in a variety of waysthrough their eggs, young ones or even the adult forms. One can pick up ectoparasites (externai parasites) such as bed bugs, lice and ticks by direct contact with them. Many intestinal parasites, acquired by insanitary habits, enter our body through mouth. Some of them have access to our body through uncooked or undercooked meat or fish, in which they may lie in the

Man shares parasites with pets

Among the protozoan parasities, visceral and cutaneous forms of Leishmania cause chronic, sometimes fatal, disease of Kala-azar and Oriental sore respectively. They occur in dogs which serve as a reservoir host. Man becomes infected at an early stage by the bite of sand fly (Phelebotomus sp.). Kala-azar is accompanied by fever, and enlargement of

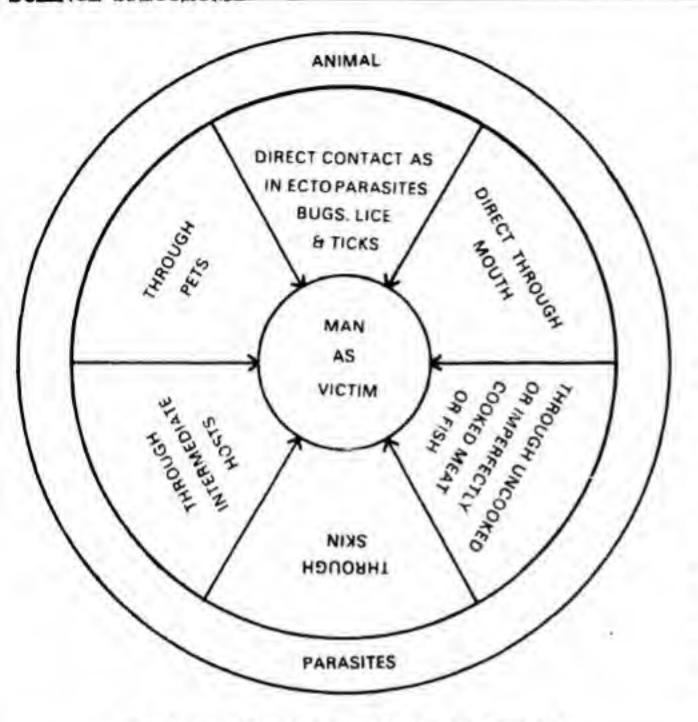


Fig. 1. Plausible modes of parasitic entry into human body

liver and spleen. Oriental sre causes one or more local sores, usually without fever.

Dogs and cats also serve as alternate hosts to Trypanosoma sp. which causes Chagas' disease in humans. The vector is the bed bug (Rhodnius However, dogs and cats sp.). often are important sources of human infection. It is an important disease in South and Central America. Chronic stage of Chagas' disease is marked by extensive hard edema, inflamed lymph glands and enlarged liver and spleen. Dogs and cats serve as additional hosts to Entamocha histolytica which is the cause of amoebic dysentery in man. Cysts are passed in the faeces of host and infection occurs by the ingestion of faecal material containing cysts. This usually through contaminated

water. The source of infection is usually man. However, dogs occasionally pass the parasite to man. Toxoplasmosis, caused by Toxoplasma gondii, is another protozoan disease in man for which dogs and cats serve as important reservoirs. The usual method of infection of toxoplasmosis is not clear. The include symptoms may fever, enlargement of lymph glands and eye disturbances. Dogs have also been reported, though occasionally, as host to Balantidium coli which inhabits the large intestine of man and causes diarrhoea and dysentery. Pigs are usually regarded as important sources of human infection.

Among the roundworms (nematodes) Ancylostoma braziliense, a common hookworm inhabiting the intestine of dogs and cats, has also been known to infect man. When infective larva of the parasite penetrates into the human skin, it often misses its way to the blood and lymphvessels and continues to wander in the hypodermal tissue. It constantly

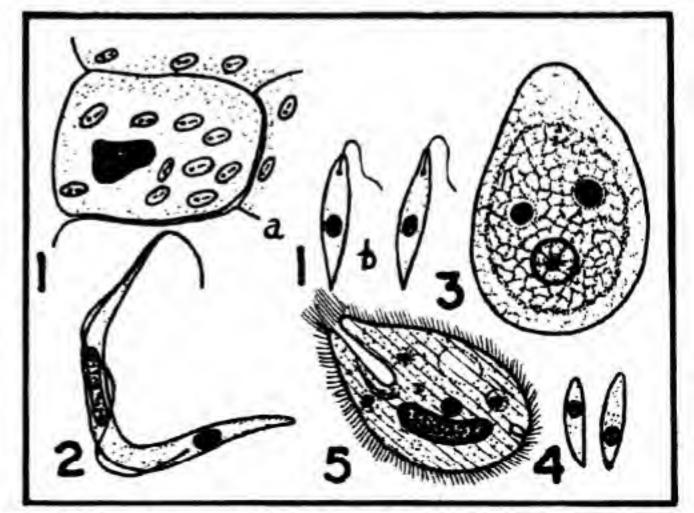
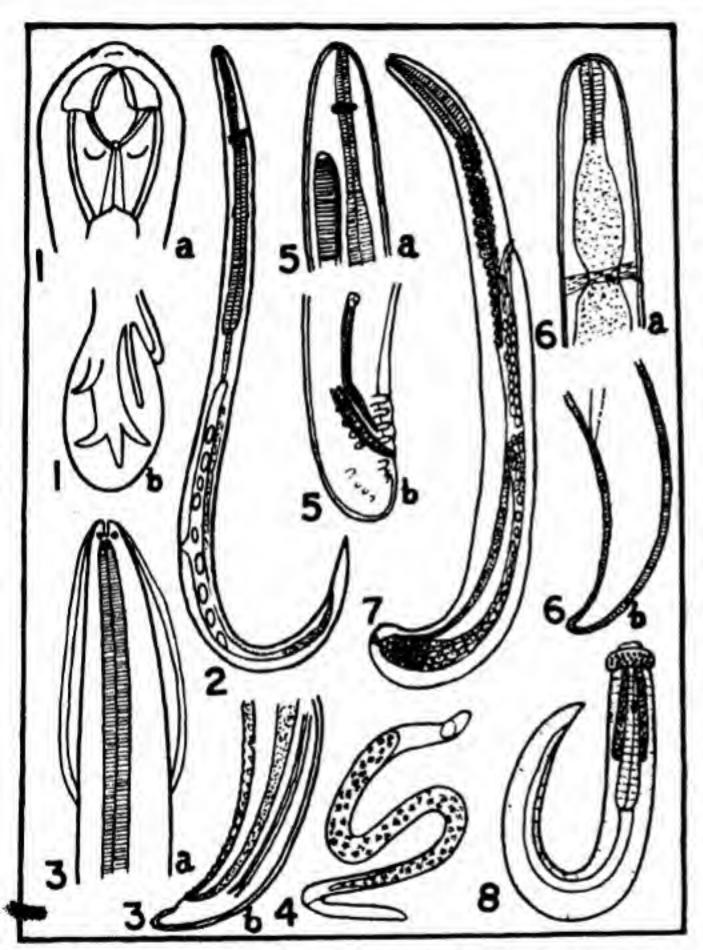


Fig. 2. Common protozoans which man shares with pets (drawn to different scales) 1. Leishmania sp.: (a) in spices cell; (b) from culture, 2. Trypanosoma, Sp., 3. Entamoeba histolytica from human intestine, 4. Toxoplasma gondii isolated from infected bost cell, 5. Balantidium coli



. 3. Common roundworms man shares with pets (drawn to different scales): 1. Ancylostoma braziliense: (a) month end; (b) hind end of male, 2. Strongyloides strecoralis (female), 3. Toxocara Sp.: (a) anterior end; (b) hind and of male, 4. Microfilaria of Brugia malayi, 5. Dirofilaria immitis: (a) anterior end; (b) hind end of male, 6. Dracunculus medinensis: (a) anterior end; (b) hind end of female, 7. Trichinella spiralis (female), Gnathostoma spinigerum (young one)

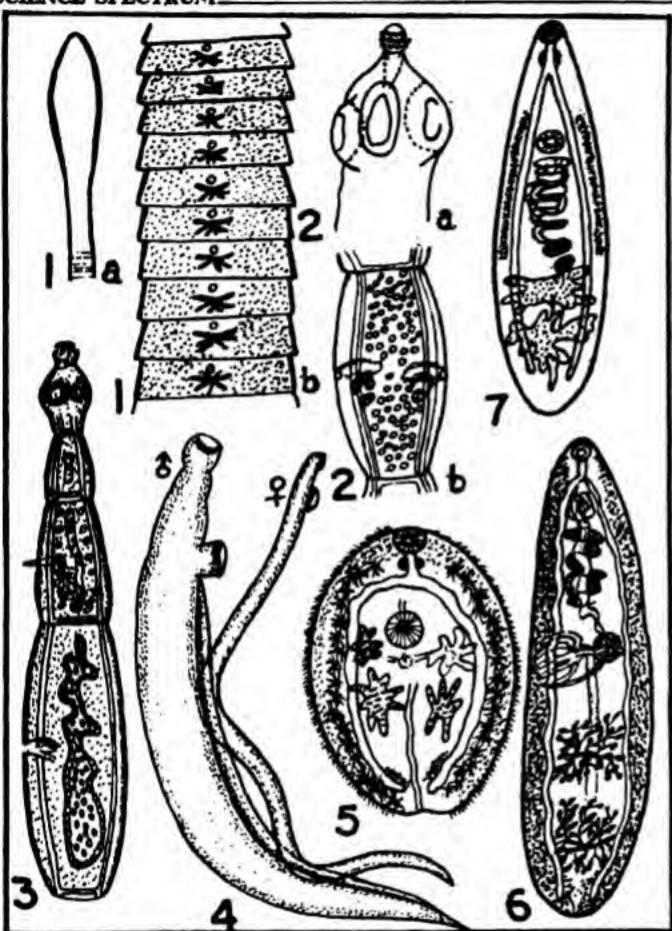
changes its place and causes 'creeping eruption'. Infection is likely
to occur at the bathing beaches where
people go barefooted. Intense itching is produced by the migrating
larvae under the skin. The itching
provokes scratching and secondary
infection occurs. Strongyloides
stercoralis—a very common intesti-

nal parasite of man, has a marked effect on skin, lungs and intestine. Man gets infection by the penetratrion of the infective larvae into the skin. Dogs and cats also serve as sources of human infection. Ascarid worms of dogs and cats (Toxocara sp.) are found commonly as adults in the intestine of these pets.

Eggs passed with the faeces of the hosts (dogs and cats) may accidently be ingested by children due to their unhygienic habits. In the intestine, eggs hatch and the larvae burrow the intestinal wall and migrate to other organs through blood stream-a condition referred to as 'visceral larva migrans', the symptoms of which are eosinophilia, fever, cough and liver enlargements. The larvae may sometimes wander to such delicate organs as the eyes where they produce serious effects. Brugia Malayi (Wuchereria malayi) which causes Malayan filariasis has also been reported from dogs and cats. When present in large numbers the worms block lymphatic vessels to cause elephantiasis, involving the legs and feet. Man gets infection by the bite of infected mosquito containing microfilariae (young ones). Dirofiluria immiti, the dog and cat heartworm, which severely affects the pulmonary arteries and heart, has been occasionally reported from man. But there is no evidence that viable microfilariae are produced by the female Dirofilaria in man. The guinea worm, Dracunculus medinensis, an important human nematode found in connective tissue, has also been



"I am sure they do not mean only animal pets."



Common flukes and tapeworms man shares with pets (drawn to different scales): 1. Dibothriocephalus latus : (a) anterior end; (b) body segments, 2. Dipylidium caninum: (a) anterior end; (b) body segment, 3. Echinococcus granulosus, 4. Schistosoma japonicom (female lying in a body canal of male), 5. Paragonimus westermani, 6. Fasciolopsis buski, 7. Clonorchis sinensis

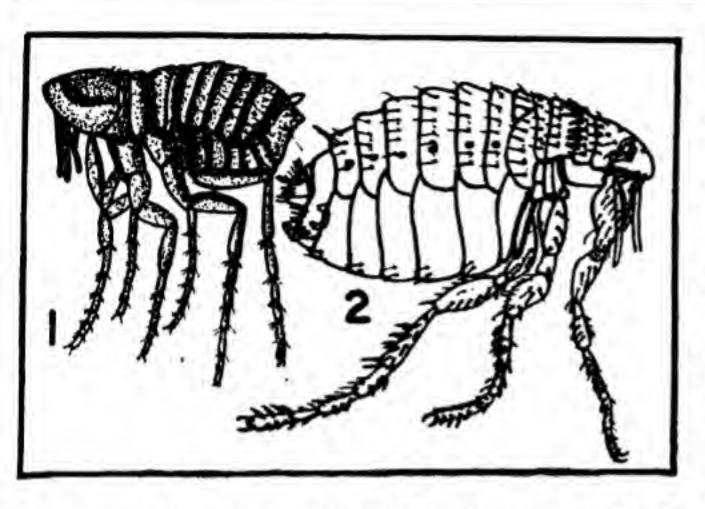
parasite produces blisters along with various symptoms like nausea and vomiting, diarrhoea, asthma, piddiness and fainting—Trichinella piralis causes a widespread disease called trichiniasis, the symptoms of which are gastro-intestinal troubles. Human beings though usually inected by eating uncooked pork are lso likely to get infection from cats nd dogs. Gnathostoma spingerum

reported from dogs and cats. The is a short worm found in the stomach of cats and less frequently in dogs. In man, these worms are often found in an immature condition in the skin tumours, although they may lodge almost in any organ including eye or brain. Wandering in the body the larvae cause a kind of swelling or creeping eruption.

> Among the tapeworms (cestodes) Dibothriocephalus latus (Diphyllobothrium latum) -the broad or

fish tapeworm reportedly found in the small intestine of man, has also been reported from dogs and cats and many other mammals. In man infection occurs by the consumption of raw or imperfectly cooked infested fish. The parasite causes abdominal pains, loss of weight, weakness and sometimes severe anaemia. Dipylidium caninum, commmonly known as dog tapeworm, is found in the small intestines of dogs and cats. Its infections also occur in children with slight intestinal disturbances and toxic nervous symptoms. Echinococcus granulosus and E. multilocularis, the small tapeworms found in the intestine of dogs, cats and other members of canine family, cause most serious larval tapeworm infections in humans, known by the name of unilocular hydatid disease and multilocular hydatid disease respectively. The eggs of the worm pass through the faeces of infested animals, and are ingested by man along with contaminated food or drink. Children are more liable to get infection when dogs are permitted to 'kiss' their faces. Ingested eggs develop into many headed larvae, the onchospheres, which are liberaed in the intestine and make their way to the various organs, developing there into spherical cysts.

Among the flukes (trematodes), Schistosoma japonicum, is a blood fluke which causes schistosomiasis in man. Besides man, it also occurs in dogs and cats living in close vicinity to man, which may act as a source of infection. The mode of infection is through skin penetration by cercariae-the infective stage larvae. Schistosomiasis results in the great enlargement of liver and spleen. Paragonimus westermani-the fluke occurring in man, is known to parasitize a number of alternate hosts including dogs and cats. Man becomes infected by taking uncooked



 Common arthropods man shares with pets: 1. Tunga Penetrans, 2. Ctenorephalides felis

or inadequately cooked fresh water crab or crayfish which serve as intermediate hosts to the parasite. The symptoms produced by Paragonimus infection, though not serious, are cough, blood stained sputum, mild anaemia and slight fever.

Among arthropods, Tunga, penetoes. The secondary infection may trans—the chigoe, 'chigger', or 'sand flea' attacks a variety of animals including poultry, humans pigs, cats and dogs. The contact with flea-infested animals is likely to produce infestation which causes flea dermatitis characterized by painful wounds on the foot or between the

cat fleas, Ctenocephalides canis and C. felis, are also parasitize human beings. These fleas are frequently in volved in the transmission of the dog-tapeworm (Dipylidium) to children.

Some precautions

Man has to pay a heavy price for maintaining pets in the household if they are not looked after properly. Dogs should be prevented from eating viscera of sheep, cattle and other slaughtered or dead animals from which they frequently get infection. Children should avoid too much intimacy with pets. Contact with sandy soil which dogs and cats may leave contaminated with faeces should be avoided. One of the most valuable prophylactic measures is periodic deworming of dogs and other pets. Sleeping quarters and immediate environment of dogs and cats should also be kept clean.

M.L. SOOD

(MISS) SUDARSHAN KALRA

Zoology Deptt.

Punjab Agricultural University

Ludhiana

BOOK REVIEWS (Continued from page 256)

up the cell functions to the coordinated functioning of the body in totality. The chapter on consciousness and behaviour explains the response of individuals to their environment, both external and internal. The concepts of consciousness is explained in terms of perception and is linked to all forms of behaviour.

The book is well illustrated and, in relation to the quality of content, is reasonably priced. Due to emphasis on physics, chemistry, etc., the book can also be recommended to those who wish to enter fields of biochemistry and biophysics at an advance research level, where it may

be useful as a basic introduction to these subjects. It will also prove useful to researchers coming from any one of the scientific disciplines by enabling them to venture into an interdisciplinary area.

> RITA PATHAK Division of Science Planning C.S.I.R., New Delhi



NEWS & NOTES

Nobel physicist Hertz is dead

DR. Gustav Hertz, the German nuclear physicist who shared a Nobel Prize for Physics in 1925 and worked for the Soviet Union after World War II, died on October 30, 1975, in Berlin, East Germany at the age of 88 years. Dr. Hertz and Dr. James Franck shared the Nobel Prize for their discovery of the "laws governing the impact of an electron on an atom". Their work on the ionization potentials of gases is regarded as of great importance in establishing the quantum theory under which energy can be taken up by the atom only in discrete quantities. Dr. Hertz was regarded as the leading member of about 200 German scientists who agreed to help the Soviet Union when Nazi Germany fell in 1945 He is said to have played a key role in Soviet Union's efforts to catch up with the U.S.A. in making atomic bombs.

Dr Hertz devised a method for separation of the explosive isotope uranium-235 needed for the making of atomic bombs. He also devised a method for separation of neon isotopes by diffusion.

A nephew of Heinrich Hertz who discovered magnetic waves, which opened the way for wireless telegraphy, young Hertz was born on July 22, 1887 in Hamburg. He studied at universities of Göttingen, Munich and Berlin, obtaining his doctorate from the University of Berlin. He fought on the German side in the World War I and was severely wounded. In 1925 he was professor of physics at the University of Halle and in 1928 he became director of physics at the Berlin-Charlottenburg Technical High School. In 1934, the year Hitler seized power, Dr. Hertz resigned from the school after he refused to take an oath for loyalty to Nazism. Nevertheless, he remained in Germany throughout World War II, and even survived it. He was then chief physicist of the industrial concern Siemens, which built a special laboratory for him. Dr. Hertz stayed in the Soviet Union until 1954, when he returned to East Germany and taught experimental physics at Leipzig University until he retired in 1961. He also received Planck Medal and Lenin Prize.

R.K. DATTA

Evolution of man in Africa

FOSSIL evidence indicating that true man had evolved and lived in East Africa 3.75 million years back.

much earlier than had been previously established, has been discovered in Tanzania. The above announce-

ment has recently been made in Washington by the renowned archaeologist Dr. Mary Leakey. She had found the jaws and teeth of at least 11 creatures that appear to belong to the genus Homo, the scientific classification that includes modern man, Homo sapiens. The above date was derived from radioactive carbon-dating of jaws and teeth excavated in December 1974, 38.5 km south of Olduvai Gorge, where Dr. Leakey and her archeologist husband Dr. Louis Leakey had made many fossil discoveries during the last two decades. Previously, the oldest reliably dated hominid or man-like fossils, were no more than 3 million years old. They include teeth found in Ethiopia by Dr. D.C. Johanson, and a skull and other bones discovered in Kenya by Dr. Louis Leakey and his son Dr. Richard Leakey. Dr. Mary Leakey said that her new fossils shared many anatomic features with younger homo fossils from Kenya and Ethiopia. She said that as a group these fossils represented a species that is clearly different from australopithecus, an 'ape man' that until recently was thought to be ancestral to modern man. The new evidence puts back the date at which the human and ape lineages are thought to have separated from a common ancestral species. From the studies of proteins of apes and humans, biochemists have put the date at 5 million years ago. According to some anthropologists, if true man existed 3.75 million years ago, then the transitional species must have arisen much eurlier in the past. In other words, the common ancestor almost surely could not have lived as recently as 5 million years ago. Dr. Mary Leakey's studies and expeditions were supported by the U.S. National Geographic Society and the radioactive carbon-dating analyses were carried out by Dr. G.H. Curtis of the University of California at Berkeley.

(Continued on page 218)



Cromolyn—a new drug for asthmatics

BRONCHIAL asthma is a condition in which there is variable reathlessness due to widespread arrowing of peripheral airways. Cromolyn, also known as cromolyn odium, disodium cromoglycate and ntal, is the latest drug for bronchial asthma. Cromolyn is derived from Chellin which is the active principle of a herb known as amni visnaga. Cromolyn is a bichromone pharnaceutical compound.

Cromolyn is a white powder with mild bitter taste. If given orally, very little is absorbed from the gastrointestinal tract. Hence, it is used by inhalation. After inhalation, he drug is absorbed by the lungs. It rapidly clears from the blood to be excreted in the bile and urine in unchanged form.

Cromolyn' has the best therapeuic effect in asthma of type I, which is he end result of an immediate hyperensitivity response. It may also proect against type III allergic reactions which occur about four to six hours ifter exposure to an antigen. It has no direct bronchodilator, antihisaminic or steroid like properties. t prevents interaction of specific illergens on the surface of the mast cells which otherwise lead to degranulation within the cell and subsequent release of histamine, 5-hydrosytryptamine and a slow reacting substance A, which cause bronchoconstriction. Hence, a pre-inhalation of the drug protects against the oncoming attack of bronchial asthma. Cromolyn is an ideal drug for extrinsic asthmas (where an external factor is involved). Intrinsic asthma, where the onset is in middle age with a family history of asthma, shows an improvement on treatment with this drug.

Cromolyn reduces bronchodilator (aminophylline) and steroid requirements, which are used in long term therapy of bronchial asthma.

Dosage and administration

To be fully effective, cromolyn has to be inhaled in doses of 20 mg, four to five times in twenty-four hours. Some authorities advocate larger doses. It is important that the patient should have a clear airway at the time of inhalation. Reflex exhalation by the patient should be avoided as moisture will clump the powder within the delivery unit of the inhaler device. Cromolyn may cause irritation of hyper-reactive bronchi, and hence a preparation containing isoproterenol is used.

A method for giving the drug to

children under the age of 3 to 4 years has been devised. 10 mg of cromolyn is dissolved in 2 ml of saline and inhaled as a mist via a face mask and Bennett twin-jet nebulizer (vaporizer which throws liquid in the form of fine spray or vapour) three to four times a day.

Cromolyn is also used as oral cromolyn in gastrointestinal allergy, paediatric milk-protein intolerance and aphthous stomatitis (dyspeptic ulcers of the mouth). Topically cromolyn has been tried in urticaria, etc. The side effects are very few and include dry throat at initiation of therapy and pulmonary infiltrates with eosinophilia (asthmatic attacks).

For cromolyn to be effective, regular treatment and gradual withdrawing of the drug is important. It remains an ideal drug for prophylactic prevention of asthmatic attacks and as a drug in between attacks of 'bronchial asthma'.

N.N. LAHA
Lecturer in Medicine
M.G.M. Medical College
Indore (M.P.)

Loss of ascorbic acid (Vit. C) in diseased plants

A sized by a variety of plant and their parts and is needed in their metabolism. The best food sources of this vitamin are 'aonla', guava, citrus, tomatoes, mango, papaya, berries, melons, raw cabbages, green peppers and many leafy green vegetables. Severe ascorbic acid deficiency produces scurvy as well as certain other diseases. Fruits and vegetables are used to supplement this vitamin.

During pathogenesis a number of fungi such as Botryodiplodia theobromae. Aspergillus niger, Colletotrichum gloeosporioides, C. papayae,
Gloeosporium papayae, G. psidii,
Pestalotia psidii, Rhizopus nigricans,
R. stolonifer, Myrothecium roridum,
Drechslera australiense, Cylindrocladium scoparium, Macrophoma allahabadensis, and Geotrichum candidum
have been reported to cause considerable loss in the vitammin C contents
of host fruits and vegetables. The
decline in the ascorbic acid content
varies with the organisms as well as
the host. This is evident from the
percentage losses in ascorbic acid

ontents in tomato fruits due to affection by Drechslera australiense, Cylindrocladium scoparium and Georichum candidum which were 98.1, 89.1 and 46.8, respectively. The rate of decrease in the quanity of ascorbic acid in the tissues of the fruits of omato and citrus infected by Georichum candidum was rather less. A decline in the quantity of this eitamin has also been observed in apparently healthy tissues adjacent to the infected regions.

It has been established that the outstanding chemical property of this itamin is its reversible oxidation and eduction between L-ascorbic acid and dehydroascorbic acid by the enzyme ascorbic acid oxidase (a copper-protein enzyme) or by certain other oxidative enzymes like polyphenol oxidase, cytochrome oxidase, peroxidase, etc.

The loss of vitamin C in pathogenesis may be due to production of some ascorbic acid degenerating enzymes either by the fungus alone or by the host-pathogen complex. Apart from this, the loss may be due to increased respiration in the diseased tissues and this may induce increased oxidation.

Vitamin C is easily destroyed by cooking as it is readily oxidized.

There may also be a considerable loss in minching fresh vegetables. Loss of vitamin C during storage and processing of fruits and vegetables is also extensive, particularly, where heat is involved. Traces of copper and other metals accelerate this destruction. Low temperature storage of vegetables and fruits before processing, canning or freezing reduces the destruction of ascorbic acid.

JAMALUDDIN Botany Department Allahabad University Allahabad

SCIENCE FOR THE YOUNG (Continued from page 252)

grows in marshy Malaysia. It nabitat and is propagated mainly by uckers. Duration of life of sago salm is 9-15 years. Pith or internal parenchymatous tissue is the place where starch is formed (This is the nain difference between Metroxylon ind Manihot plants. In the latter ase starch is formed in tuberous oots of plant). At this stage the plant is ready for starch extracion. Stem is cut into small pieces ind split up. The pith is taken out nd pounded with water and strained. The starch which settles down it the bottom is washed and dried. Starch of good quality is used or preparation of sago pearls or dobules The kneaded paste of tarch is passed through a wire mesh ind is then shaken in a shaker with a cloth lining. Now it acquires

the shape of the globules. Globules which are slightly wet are roasted over fire on a metal pan smeared with vegetable oil such as coconut oil. A layer of gelatin is formed around the pearls. On an average a single palm plant yields about 113-300 kg of sago, sometime it may go up to 545 kg.

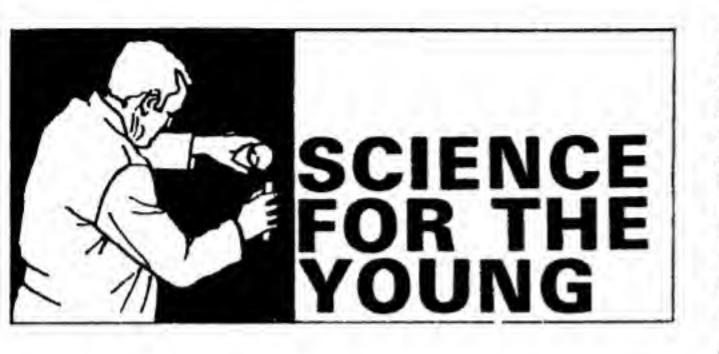
Manihot esculenta, commonly known as tapioca, also yields of large quantity of sago. Earlier sago was imported from Malaya, Singapore and Indonesia. In India it is obtained from Manihot, because during the Second World War its import was stopped. As far as nutritional value is concerned tapioca sago is no less than palm sago. Sago industry is located in Kerala and Tamil Nadu. The plant is a native of Brazil, but is grown in all the

warmer parts of the world. In India, Kerala is the largest producer of tapioca where it forms the food of the poor; second in rank is Tamil Nadu. Tapioca is a shruby plant 1-2m in height. Sago starch is obtained from large, spindle-shaped cluster of tuberous roots. Processing of starch from sago globules is basically the same as for the palm starch.

Apart from large proportion of starch (87.1%), it has small amounts of proteins (0.2%), calcium (1%), phosphorus (1.%), fat (0.2%) and fibres. Percentage of iron is 1.3 mg/100 gm. Nutritionally it cannot compensate any other food, though its caloric value is quite high (351/100).

India produces nearly 150,000 tonnes of sago per annum.

NISHA BAJPA



Big and small numbers

WE are familiar with the quantities and numbers we have to use n everyday life. But in science ve often have to deal with very small nd very large quantities and numers. For example, the length of a book or a table can be measured in entimeters or meters. But the disance from earth to sun or pole star s very large. On the other hand, the liameter of an atom is extremely mall. Similarly, in the case of other physical properties (such as mass, ime, force, etc.), we can think of ery large and very small quantities. We shall discuss some in this rticle.

ength

Let us first consider those objects which we encounter in everyday life. The length of a book may be 20 cm or 30 cm; that of a table may be 200 cm, while the height of a mountain may be 5 km=5×105 cm. The distance of sun from earth s about 1.5×1013 cm, while the distance from one end of our galaxy, Milky Way, to the other is about 10ss cm. By means of the most powerful telescope available at present, galaxies at a distance of 1026 cm have so far been spotted. On the other hand, the diameter of a hydrogen atom is about 0.00000001 cm or 10 cm. The nucleus at the centre of an atom has a diameter of about 10⁻¹³ cm. This is the smallest distance known or measured so far.

For expressing small distances encountered in atomic physics a special unit is used. This is known as an Angström, a word derived from a Swedish physicist of the same name, Anders Jones Angström (1814-1874). One Angström equals 10-8 cm. Similarly, 10-4 meter=10-4 cm=104 Angström is called a micron.

For very large distances with which one has to deal in astrophysics, another special unit is used. This is known as a light-year and it is equal to the distance travelled by light in one year. The velocity of light in vacuum is 3 x 1010 cm/sec. Since there are about 3.154 × 107 seconds in a year, the distance travelled by light in one year is 9.5 x 1017 cm. It should be borne in mind that lightyear is a unit of distance, not of time. The star nearest to us outside the solar system is about 4.28 light-years away. The linear expension of our galaxy (from one end to the other) is about 100,000 light-years.

Mass

Once again, let us consider everyday objects. The mass of a gram may be one gram, that of a potato may be 50 gm, that of a bicycle may be 10 kg 10^a gm, and that of a railway train may be 1000 ton -10^a gm (one metric ton 1000 kg -10^a gm.). But the mass of earth is about 6 × 10^a gm and that of sun is about 2.5 10^a gm. On the other hand, the mass of a proton is 1.67 × 10^{-2a} gm and that of an electron is 9.1 × 10^{-2a} gm. An electron is the lightest particle known so far (excluding massless particles such as photon and neutrino).

Time

The earth rotates about itself once in a day (86400 seconds); it revolves pround the sun once in a year (3.1536 > 107 seconds) The life span of man is about 100 years or a little more than 10" seconds. It is believed that the time clapsed from the Vedic period till now is about 5000 years-1.5 × 1011 seconds. It is also believed that the species of man originated about 1018 seconds ago; life on earth (in its primitive form) began about 1016 seconds ago, and the universe itself is about 1017 or 1018 seconds old. On the other hand, light takes about 10-10 sec to travel a distance of one cm; the periodic time of X-rays is about 10-20 sec or less. So far intervals as small as 10-14 sec have been measured.

Force

The force acting between two electrically charged particles is given by the formula $q_1 q_2/r^2$, where q_1 and q_2 are the electrostatic charges on the two particles and r is the distance between them. If the particles have charges of one e.s. u each and are at a distance of one cm from each other, the force acting between them is one dyne.

Let us now imagine a proton and an electron as in a hydrogen atom. The particles have electric charges of magnitude 4.8 × 10⁻¹⁰ e.s.u., though the proton is positively charged and the electron is negatively charged. It we take the distance between them as 10⁻⁸ cm, the force between them comes out to be 2.3 × 10⁻⁸ dyne.

The gravitational force between two particles or bodies is given by the Newton's formula, G m, mg/r2, where m, and m, are the masses of the two bodies, r is the distance between them and G is the universal constant of gravitation. If masses are measured in gms, distance in cms and force in dynes (that is, c.g.s. units), the value of G is found to be 6.67 × 10". Let us now calculate the gravitational force between a proton and an electron in a hydrogen atom. If we take the distance between them as 10-4 cm and use their masses given earlier, the gravitational force between them comes out to be about 10-42 dyne. We see that this is negligible in comparison to the electrostatic force between them. The gravitational force between the earth and the sun is about 3.56×10^{27} dynes.

Those small quantities which are used in connection with atoms, molecules and elementary particles are called microscopic quantities. The part of the universe connected with them is called microcosm. Those large quantities which are used in everyday life or are connected with planets, stars and galaxies are called macroscopic quantities, and the part of the universe connected with them is called macrocosm. There is very little difference, only of one letter, in the two words "microcosm" and "macrocosm", but a vast difference in their meanngs!

Macrocosm can again be divided into two parts. Those objects which we see or with which we deal in everyday life form the "everyday world", and those which are connected with heavenly bodies form the "astronomical world".

Energy

When a mass of one gm moves with a velocity of one cm/sec it has a kinetic energy equal to my = 1 erg. When a mass of one gm

is kept at a height of one cm above the surface of earth, its potential energy is mgh = 981 ergs. The thermal energy of an atom at a temperature T is equal to kT, where k is the Boltzmann's constant having value 1.38 × 10-14 erg/degree. At the normal temperature of T=300°C, thermal energy is about 4×10-14 erg. The highest energy of elementary particles so far detected in cosmic rays has been found to be as much as 10s ergs. When mass is completely converted into energy, the energy is given by the Einstein's formula E=mc2. If a mass of one gm is completely converted into energy. the energy generated will be about 1021 ergs.

It is estimated that the sun gives out an energy of about 4×10^{32} ergs per second, which is constantly radiated in all directions. Out of this, we receive energy of about 10^6 ergs per second per square cm on the earth. To create energy of 4×10^{33} ergs, Einstein's formula shows that a mass of about 4.5×10^{32} gms. 450 erore kg will have to be completely

that the sun is losing about 450 crore kg of mass every second. The sun which is an average star, neither too small nor too big, has been radiating out this energy for crores of years and will continue to radiate as long.

How many particles?

One gram of any substance contains about 10²¹ to 10²² atoms. Since the mass of earth is about 10²⁷ gms, it is estimated that the earth has about 10³⁰ atoms. Similarly, the sun has about 10³⁰ atoms. Each galaxy has about 10 to 100 crores of stars like the sun, and there are crores of such galaxies in the universe. If we regard protons, electrons, etc., as elementary particles, it is estimated that there are about 10⁷² to 10⁷³ particles in the universe.

Isn't it invigorating to imagine such small and large quantities?

> A.W. Joshi Depit. of Physics Meerut Univ. Meerut

Pens: their development and working

THE invention of pen is attributed I to Chinese. It was then in the form of brush. Reed per, or pen made of bamboo, was used during Egyptian era. But the pen in use since times immemorial, though claimed to have first appeared in 7th century, is the quill pen-the pen made of bird's feathers. The subsequent improvement over this writing device was to make a nib of quill and slip it on to a holder for writing. No sooner nibs came into being than nibs of various stouter materials, e.g., horn, tortoise shell, were produced whose tips were made pointed and durable by making use

of diamond, ruby or any hard material. As the hardest substance was required for points, metals were brought in use. Subsequently the steel pen nibs arrived.

Until fountain pen was invented in 1884 by L.E. Watermann, a pen was simply a holder to which a nib was slipped on. The pen had to be dipped, time to time, in ink pot to write. Watermann removed this drawback by introducing a reservoir and a feed. In 1937, a Hungarian in Argentina, Laszlo Jozef Biro, invented a workable ball-point pen. It immediately became popular with the armed forces be-

first, temperature and pressure of surroundings do not affect its working as is the case with fountain pens. Second, it can be used for considerable lengths of time without replenishment of ink.

A third type of pen was recently invented by Japanese in 1964 but is not yet so popular, and is used only where the fountain pen or the ball-point pen does not serve the purpose. It is the fibre-tipped pen.

Fountain pen

It consists of a reservoir in which ink is stored; a feed which contains capillary channels to circulate ink and air flow, and a nib which has a pointed tip that writes on the paper.

The reservoir in an ordinary pen is an eye-dropper or a piston type. In the former, there is a lever by which the rubber reservoir is inflated or deflated of ink. In the latter, a piston serves the same purpose. However, in both the cases suction is utilised for drawing ink in the reservoir In piston type, there is an inlet for air at the rear end of piston tube. It enables the piston not to create suction when it is pushed up to the rear end of the tube, and so does not hinder its forward movement.

The reservoir is connected to the feed made of plastic or hard rubber. The feed comprises of channels of capillary dimensions, one for the incoming air and the other for the outflowing ink. The capillary action of these channels enables to keep a balance of pressure inside and outside the pen. It helps in holding the ink in the reservoir against gravity. Alongside the capillaries, there are also comb cuts. These cuts are meant for accommodating the excess ink that may otherwise disturb the ink flow. For continuous writing the cuts help to

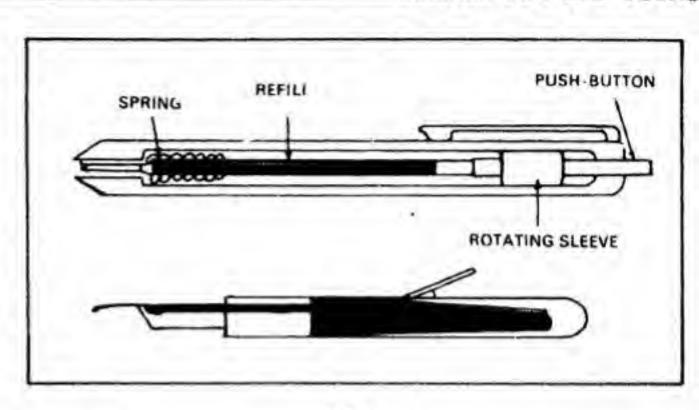


Fig. 1

maintain the flow of ink to the nib point.

The nib, as is apparent to any pen user, has an 'eye' from which a hairlike slit emerges to end at its point. It is the function of the slit to regulate a fine thin flow of ink to the point, so that it could write on the paper. As soon as the point touches the paper, the pressure of the writing hand slightly sprays it apart allowing for a good flow of ink. As the cells of paper absorb ink. they draw more of it from the slit in the nib. The ink starts flowing out, and is continuously replaced by the air entering through the 'eye' hole of the nib. A pen, already filled with ink, stops working when the capillaries get clogged, or starts leaking excessively if the pressure balance is not maintained because of the atmospheric conditions. That is the reason why fountain pens leak at high altitudes where atmospheric pressure is very low.

The nibs whose material should be resistant to the corrosive action of ink are generally made of stainless steel or 14 carat gold. The nib point vary according to the thickness of the writing desired.

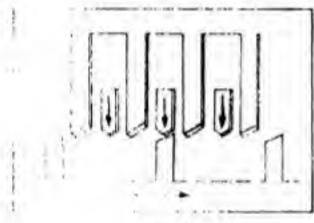
Ball-point pen

Before coming to how the 'clickclack' of a ball-point pen takes place, the working of a vital component of the pen refill or reservoir -needs elucidation. The reservoir which contains a thick viscous fluid is a long cylinderical narrow tube. Its one end is plugged with a ball-point tip and the other open to atmosphere. The ink flows on to the paper from the tip. In fact, the tip contains a small metallic ball which rotates freely as the pen is moved over the paper. Because of the rotation, the ball is always enveloped by a thin film of the viscous fluid present in reservoir, and which it transfers ento paper as it is pressed. The fluid dries on the paper by absorption or evaporation depending on whether the fluid is made of oil or spiritsoluble dye. But what keeps the fluid from leaking out of the tip? It is the high viscosity of the fluid. And what about the other, open end of the reservoir? There is a material called 'follower' corked at that end. It is of such viscosity that it becomes a solid 'barrier' to the back-flow, i.e., leakage of the fluid from the rear end, but is liquid enough to follow the fluid down to the tip where it would be used as ink.

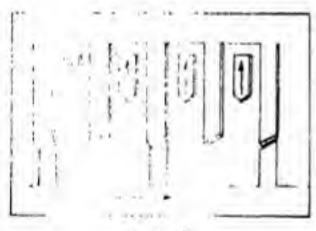
The ball is usually about 1mm in diameter. The size can be different in special type of pens. It is made usually of steel or synthetic saphire in high quality pens, it is made of



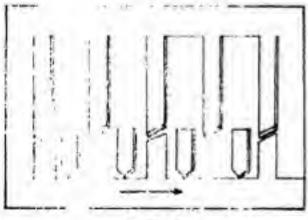
Step. 1



Step. 2



501



Step. 4

1 4 2

to the to the to the tip to the boy, and when pushed prets retract that the

body. This looks subtle, but in practice it is trivial.

The various inner components of of an 'automatic' ball-point pen are illustrated in Fig. 1. The working mechanism of pen comprises of a push button, a rotating sleeve connected to cear end of the refill or reservair, and a spring fixed at tippart of the refill. For how mechanism works, consider the steps in Fig. 2. The rotating sleeve has sharp teeth as shown. At the upper part of the body of the pen there are grooves or slots. Lastly, the lower part of pushbutton has teeth which could easily fit in the grooves of body. These grooves enable vertical up and down movements smoothly. Another point that should be borne in mind is the direction of the acting tension of spring on the rotating sleeve

Step 1 is the inside the pen when it is not used for writing, i.e., the tip of the relill is inside the body. When the push butten is pressed, what happens inside is depicted in step 2. The push button pushes the sleeve down, that in turn pushes the reservoir down, so that tip juts out of the body. When the push button is released, it slips off the teeth of the sleeve on to the edges of the body The rotation required for this motion is provided by the spring attached to the reservoir (step 3). The tip being outside the body and held in that position, enables one to write.

When there is a need of pushing the tip in the body, the push button is again pressed down. This action shown in step 4, disturbs the rotating sleeve, and because of spring tension, it slips off the position held till then and assumes the original position (step 1). The role of the spring at the lower part of the pen is vital. That is why if it does not work the automatic mechanism of the pen fails. In a costly pen, the push buttor has a spring too. In such a case, it is usually this spring which rotates the reservoir; the mechanism is a bit different, that's all. Some pens are ball-operated—a ball held within a cam recess inside the pen helps in the push button action.

Fibre-tipped pen

It has a wedge shaped felt nib whose points are made of nylonaerylic dacron, nylon, rayon, plastic, etc. There is no reservoir as such in the pen. The nib has a fibrous wick attached to it which is saturated with ink. An air-tight, leak proof plastic or metal tubing encloses the wick. The tip of the pen has also a cap to cover it when not in use and for keeping it moist and ready for use. Ink remains in the nib part in a substantial quantity, because of the wick action (capillary action of the porous holes), for instant writing, This pen is used for markings on glass, cellophene, plastic, and wet negatives. The ink which is indelible has a petroleum base.

DILIP M. SALWI

How sago pearls are formed

SAGO, the Sahudana is an excellent food for children and the sick. It is a light food and could be digested easily. Sago globules are cooked (with sugar and milk) as porridge or Kheer.

Sago globules are obtained from number of plants such as potato, sweet potato, Caryota and Metroxylon plants, and Manihot (casava), but the source of true sago is Metroxylon sagu, a member of family Palmae, and Manihot esculenta of the family Euphoribiaccae.

Metroxylon sagu-sago palm, a small tree of 10-12 m height and about 1-50 m girth, is a native of

(Continued on page 248)

111.15. 1

1.0

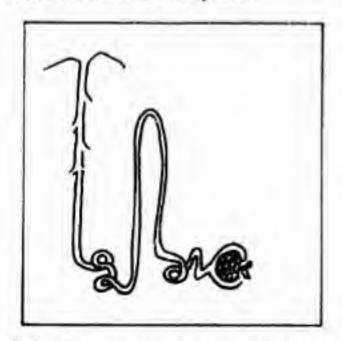
4.75

4

Believe it or not



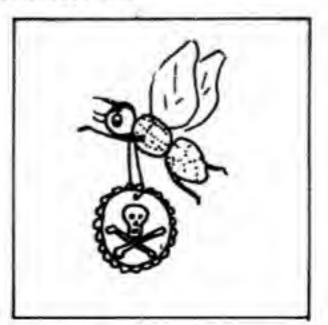
HEART is the central pumping station of the cardio-vascular system. Though it is a tiny organ, it performs tremendous work. The heart expels about 70 ml of blood in each beat. If the life span of man is taken as 70 years, the work done by the heart during this period is equivalent to the work done in carrying a weight of 10 tons to a height of 10 miles. Heart pumps about 150,000 tons of blood in 70 years.



THE structural and functional unit of a kidney is called a nephron. Each nephron consists of two parts—Bowman's capsule and renal tubule. Renal tubule in humans is about 3 cm long. There are about 2 millions of nephrons in two kidneys. The total length of the tubules thus comes out to 60 km!



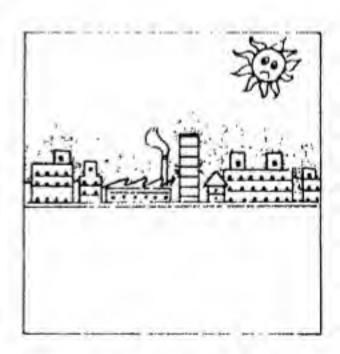
YOU know that snakes change their skin, but have you heard of a toad doing so? The Blomberg's toad of South West Columbia changes its skin once every 3 to 10 days. Kicking its arms and legs free from the old skin, it rolls the old skin into a ball and swallows it. This nine inch long grant lives on insects and possesses a coloured poisonous skin.



A ccording to many scientists the most dangerous animal in the world is the common housefly (Musca domestica). They are carriers of many diseases including typhoid fever, tuberculosis and amoebic dysentery. A single housefly can harbour 33 million germs in its intestine and more than 100 million germs on its body and legs!

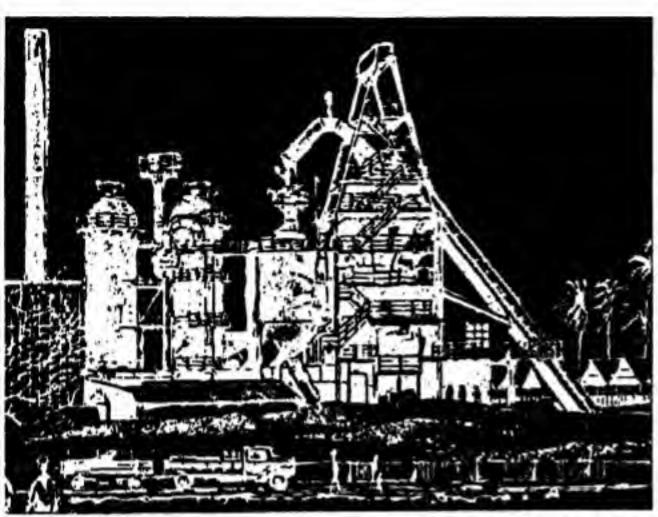


A fullstop, the dot which indicates the end of an English sentence, has a weight of its own! Scientists of New Brunswick Atomic Energy Agency, USA, have experimentally proved that a fullstop weighs .000 9922325 mg.



SIA water contains salts. The total amount of salts in the water of all the seas of the world is 50 quadrillion (16 zeros after 5) tons. But this large amount cannot be comprehended meaningfully. If the salts were separated from water by any means and spread uniformly over the earth, all the cities of the world will go under 152.4 meter of salts.

SANKAR LAI SAHA



SCIENCE IN INDUSTRY

Fly ash for reinforced and prestressed concrete

DURING the Fourth Plan period, it was estimated that about five million tons of fly ash were available from thermal power stations in India; and with the installation of new thermal plants during the Fifth Plan period, this figure can be expected to double.

These vast quantities of fly ash create problems of storage, disposal, and pollution. Expenditure of several crores of rupees is involved in disposing of this waste product. The Structural Engineering Research Centre (SERC), Madras, has therefore initiated studies to perfect methods to utilise this waste material and thus save cement. Fly ash has been successfully used in mortar and concretes of all grades in the USA,

Europe, Australia, and Japan. In India, athough it has been used as a pozzolana, as an admixture and as fine aggregate in plain concrete, its use as partial replacement of cement in medium and higher grades of structural concrete has been very limited.

To demonstrate the use of locally available fly ash and the consequent savings in cement that can be realized, an experimental construction of a large two-storeyed building incorporating cement—and steel saving techniques has been carried out at SERC. Fly ash availabe as waste product from the Basin Bridge Thermal Power Station at Madras was used for this investigation. The chemical composition of the fly ash depends upon the type of coal used, temperature and duration of firming in boilers, and many other factors such as fineness of the pulverised coal. Therefore, the fly ash samples were occasionally analysed for chemical composition.

After ascertaining the suitability of fly ash on the basis of its chemica analysis, preliminary experiments were carried out on fly ash concrete. A reference mix of a specified grade without fly ash was first designed by standard procedures. The mix was then modified by partial replacement of cement with fly ash.

The floor and roof elements of this building are channel units in prestressed and reinforced concrete using fly ash to replace 10 to 20% of cement respectively. The span of the channel units varies from 4 m. to 7.5 m. Units of 7.5 m length are made of prestressed concrete, pretensioned in the casting yard. The shorter units are in reinforced concrete. Simple and inexpensive masonry moulds were used for casting the units.

The above study has led to the following conclusions:

Fly ash may be used as partial replacement for cement in structural concrete components including in prefabricated units in construction works in the neighbourhood of thermal power stations.

- Precast channel units can be used as an efficient structural system for spans above 3 m. without the use of heavy erection equipment.
- Whenever higher workability and impermeability is required for concrete, use of fly ash as partial replacement will be very advantageous.
- 3. There need be no fear of corrosion of steel either in reinforced or prestressed concrete if the chemical composition of fly ash satisfies reccommended specifications (IS: 3812).
- Fly ash can be freely mixed with other ingredients of concrete if machine mixing is resorted to.

reblending of fly ash with cement not necessary in such cases.

The use of fly ash concrete tructural components in the twostoreyed building has generated considerable interest in several construction agencies and housing boards.

Economic significance of lotus (Pamposh)

THE name Pamposh is given to the only Asiatic species Nelumbion nucifera Gaertn. (Syn. Nelumbium speciosum Willd.) belonging to the amily Nymphaceae. It is a native of China, Japan and possibly India. The crop is reported to yield 600-4600 Kg of rhizomes per hectare (Bailey 1947). The plant is so important that every part has a distinct name and supplies one or more drugs. This information is scattered in literature and is compiled hercunder for ready reference.

Starting from the roots, the powdered root is prescribed for piles, as a demulcent; also for dysentry and dyspepsia. It is used as a paste in ringworm and other cutaneous infections

The long white rhizomes resemble string of sausages, each about 30 cm long and separated from others by a constricting fibre. These constricting fibres are used medicially in China and are credited with the property of restoring health of persons suffering from exhaustion. Their special action is regarded as haemostatic. In Ceylon, an aqueous extract of fresh rhizomes of white dowered variety is given internally in doses of 1-4 ounces for bites of snake and tarantulas. It is said to be specially useful in bites of cobra.

The large leaves are used as cool bedsheets in high fever. The milky uice of leaves and petioles is given in diarrhoea. Flowers are ornamental and used for offering in temple. These were once used as a source of lotus perfume which was highly priced. The flowers are used as an astringent in diarrhoea, cholera, in fever and diseases of liver; and also recommended as cardiac stimulant. The honey from the bees which visit these flowers is reported to possess

tonic properties and considered useful for afflictions of the eye. In Tamil Nadu the flowers are considered diuretic. Boiled with milk and equal amount of flowers of Eugenia jambolana to a pasty consistence, it is administered to woman for false pains in early months of pregnancy.

Stamens are considered astringent and cooling, and are useful for burning sensation in the body, menorrhagia and piles. Seeds are used for checking vomiting and in formation of a cooling medicine for cutaneous diseases and leprosy. Seed flour is used as a valuable food

The germinating embryo is used for reducing high fever.

> M. K. KAUL Regional Research Laboratory Sanat Nagar Srmagar-190005, Kashmir

High protective enamels for aero-engine components

CPECIAL enamel compositions for protecting the exhaust systems of jet aeroengines against high temperature corrosion by exhaust gases were developed earlier at the Central Glass & Ceramic Research Institute, Calcutta. Working conditions for 10 kg batch production of such enamels were standardised and 150 kg of the material was supplied to Hindustan Aeronautics Ltd., Koraput Division, for flight evaluation tests. High temperature enamel CGB-55 as well as standard specification CG-HT-NCW-73 developed at the Institute have received final

approval from the Directorate of Aeronautics for use on components of turbo-jet aeroengines by HAL, Koraput Division.

Researches carried out at the Institute have resulted in direct saving of more than Rs. 5 crores in foreign exchange, in addition to indirect benefits accruing from quality improvement of products and standardization and development of new capabilities, innovation of new products and processes, beneficiation of indigenous raw materials and other technical assistance to industry.



PHOTOSYNTHESIS (First Wiley Eastern Reprint) by E. Rabinowitch and Govindjee, Wiley Eastern Private Limited, New Delhi, 1970, Rs. 15.

THE spectrum of plant physiology L is so vast that a general book on the subject can hardly justify the inclusion of a single chapter on photosynthesis. For a layman, photosynthesis is the process by which plants manufacture food in the presence of a green plant pigment, chlorophyll, with the help of water from the soil, carbon dioxide from the atmosphere and light from the sun. It is a unique feature of only the green plants, and represents the most fascinating manifestation of biological evolution on the earth. physicochemical mechanism involved in this process is very complex and forms a rendezvous for physics, chemistry and biology. The book under review is an outstanding contribution to the field of photobiology. The authors (first author is no more), leading authorities in the field, have attempted to explain the various phenomena like energy, entropy, free energy, bond strength, oxidation-reduction potentials and the structure and composition of photosynthetic apparatus.

The opening chapter provides a brief historical account on the major discoveries in the field of photosynthesis. In the subsequent four chapters the authors explain the basic physicochemical phenomenon involved in the entire process. The sequence of chapters itself reflects the

order of different steps involved in the actual process of photosynthesis.

The authors have discussed the different concepts proposed by different photobiologists without giving undue importance to their own theories, although the senior author (E.R.) received the Nobel Prize for his work on the same subject. The inclusion of details such as the names of different scientists involved in the study of photosynthesis and the places where the research has been carried out makes the reading very interesting as well as gives the students an idea on the different types of work in progress in the different laboratories. Moreover, the philosophical approach, thought-provoking questions and meaningful discussions have enhanced the value of the book, both for teaching and research. The lucid exposition of the subject makes it understandable even to undergraduate students. Of course, as the authors put it, "Generations of biochemists, biophysicists and biologists will have their life-work cut out for them until photosynthesis becomes fully understood and mastered by man."

Compared to the wealth of information contained in the book, the price is not prohibitory for a student who is keen to peep through the details of photosynthesis.

JOSE KALLARACKAL
Department of Botany
Sri Venkateswara College
New Delhi-110021

HUMAN PHYSIOLOGY—THE MECHANISM OF BODY FUNC-TION, Sherman J. and Luciano D. Tata McGraw Hill Publications, New Delhi, 1975, Pp. 614, Rs. 39.

Industrialization gave birth to a new civilisation. The fast moving, highly competitive social framework has raised new problems. Supersonic jets, travelling at great speeds, overcrowding life in sky-scrapers, noise pollution, all visible signs of industrialization and pros-

perity have caused both physical a well as mental strains effecting th external and internal environment of human body. These are problem which the scientists and sociologist have to solve for the welfare of man kind, which under severe strain have not only attained serious pro portions but also complex dimen sions. No one field of science car tackle it alone. This needs an inter disciplinary and integrated approach All the more so, since it is only th inter-disciplinary approach which aims at providing the picture o human body in its totality of interna as well as external functions. As a result, the frontiers of science have developed in such a manner that it is difficult to distinguish one discipline from another. Therefore, the growth of relatively new subjects-biophysics, biochemistry, molecular biology and the contribution of traditional disciplines like mathematics, physics and chemistry—is a significant phenomenon.

The book under review includes application of laws of physics and chemistry necessary for understanding the functioning of human body. The laying of emphasis on these areas instead of dealing with the topic in a classical style has given physiology a new look which evokes understanding and interest. The other salient feature of the book application is the discussion on of biophysics, biochemistry, etc., in understanding physiology. The book can be recommended for the Indian medical graduates where it can supplement their present prescribed reading. The biophysical and electrophysiological aspects of cardiac muscle physiology and circulation have been thoroughly dealt with. The central chemical control of breathing, regulation of metabolism, basic biophysical features of skeletal muscle and nervous system have been discussed in detail. A comprehensive and complete picture of the functioning of human body has been successfully drawn. The authors link

(Continued on page 244)

COUNCIL OF SCIENTIFIC AND INDUSTRIAL RESEARCH

ADVERTISEMENT NO. 5/76

It is proposed to appoint a Scientist 'F' (Deputy Director) for the Central Salt & Marine Chemicals Research Institute, Bhavnagar with the following qualifications, etc:-

Joh requirements: Should be able to develop investigations and coordinate the projects in the fields relating to marine chemicals, sea water desalination, solar energy utilisation and allied fields in the discipline of chemical engineering. The selected candidate should be able to command the confidence of researchers in his field and the industry concerned.

Qualifications: High academic qualifications in the field of chemical engineering preferably with a Doctorate in chemical engineering having atleast 10 years experience in R & D work in the fields relating to marine chemicals, sea water desalination and solar energy utilisation, as evidenced by published Papers of high standard. He should be able to plan, guide and coordinate research in the fields relating to sea water desalination, solar energy utilisation and allied fields.

Salary/Conditions of Service: The salary scale attached to the post is Rs. 2000-125/2-2,500. Initial pay will be fixed according to the merits. The person selected will be appointed on contract for a period of six years, which would be confirmed after an initial period of two year's of satisfactory service. Other conditions of contract will be supplied on request.

Age Limit: Below 50 years, relaxable in special cases. Scientists/Technologists interested may obtain a standard proforma for sending their curriculum vitae from the Chief (Administration), Council of Scientific and Industrial Research, Rafi Marg, New Delhi-110001. They can also obtain a brochure on the aims and objects and the latest annual report of the Institute. Completed curriculum vitae proforma must be received in this office on or before 1st May, 1976.

"Canvassing in any form and/or bringing in any influence political or otherwise, will be treated as a disqualification for the post."

Did Space Explorers Visit Ancient Egypt?



Recent theory in Archaeology suggests that visitors from outer space landed in Egypt in prehistoric times.

Evidences such as paintings of spaceships, helmeted creatures, curious coincidences in the matching of the Pyramid's dimensions with distances between the planets and the sun and still inexplicable engineering feats involved in building the Pyramids are salient points for this theory.

Nobody can bet on the above theory, but the Guaranteed Reagents of Sarabhai M. Chemicals are the indispensable tools for laboratories to decipher this riddle and many other mysteries of modern science.

Cur Laboratory Reagents play the invisible role in all scientific endeavours from archaeology to oceanography.



SARABHAI M. CHEMICALS

Where scientific tradition of ingenuity never dies

Shilpi 2 SM 70/73

SCIENCE REPORTER

THE INCREASING MENACE OF NOISE

PROTEINS FROM PETROLEUM

LIGHT ON LIGHTNING AND

PHOTOGRAPHY WITHOUT

AGGRESSION IN NATURE

THE LOCH NESS MONSTER

-A MYTH OR REALITY?



Re. 1.00

OUNCIL OF SCIENTIFIC INDUSTRIAL RESEARCH



ADVERTISEMENT TARIFF FOR SCIENCE REPORTER

ORDINARY POSITION

SIZE	CASUAL	CONTRACT SIX INSERTIONS	CONTRACT TWELVE
FULL PAGE	Rs. 800.00	Rs. 4200.00	Rs. 8000.00
HALF PAGE	Rs. 450.00	Rs. 2550.00	Rs. 5000.00
OHARTER PAGE	Rs 250.00	Rs 1250 00	Rs 2500 00

SPECIAL POSITION

SECOND, THIRD, BACK COVER PAGE OR PAGE FACING SECOND COVER PAGE

SIZE	CASUAL	CONTRACT SIX INSERTIONS	CONTRACT TWELVE INSERTIONS & ABOVE
FULL PAGE	Rs. 1000.00	Rs. 5500.00	Rs. 10,000.00

COLOUR: Rs. 250.00 for each additional colour.

MATERIAL: Mounted original Zinc Blocks and Layout.

TERMS

- 1. Matter is accepted upto 15th of each month for the next issue.
- 2. Additions and cancellations, if any, must reach on or before 20th.

COUNCIL OF SCIENTIFIC AND INDUSTRIAL RESEARCH

ADVERTISEMENT NO. 15/76

It is proposed to appoint a Scientist 'F' (Deputy Director) for the National Environmental Engineering Research Institute, Nagpur.

Job Requirements: The incumbent should be conversant with present problems of research in Public Health Engineering and be able to undertake, guide research and development work in the Institute. He should also be able to provide necessary assistance to industry and assist the Director in the management of the Institute and interaction with the Government and Public Bodies. He should be able to command the confidence of researchers in his field and the industry and be an able administrator and image builder to the Institute.

Qualifications: High academic qualifications in Public Health Engineering or related science with good research and field/or operational/or design experience in a senior and responsible capacity in one or more of the following fields:—

- 1. Water supply
- 2. Sewage treatment and refuse disposal
- 3. Treatment of industrial wastes

The candidates must have experience of at least ten years in these fields. Candidates must possess extensive research experience in the field of water treatment technology and/or treatment of wastes. Experience of R&D activities with reference to national programmes in the above areas will be necessary. Qualities of leadership and ability to organise research, advisory and extension work. Original contribution in research and/or development evidenced by publications.

Salary/Conditions of Service: The salary scale attached to the post is Rs. 2,000-125/2-2,500.

In case no candidate is found suitable for appointment in the advertised scale of pay, the candidates will be considered for appointment in the scale of Rs. 1800-100-2000-125/2/2250 OR Rs. 1500-60-1800-100-2000.

The person selected would be eligible for appointment on contract for six years (including the probation period) after successful completion of probation period of two years. Other conditions of contract will be supplied on request.

Age Limit: Below 50 years, relaxable in special cases.

Scientists/Technologists interested may obtain standard proforms for sending their curriculum vitae from the Chief (Administration), Council of Scientific and Industrial Research, Rafi Marg, New Delhi-110001. They can also obtain a brochure on the aims and objects and the latest annual report of the Institute. Completed curriculum vitae proforms should be received in this office on or before 6.6.1976.

"Canvassing in any form and/or bringing in any influence political or otherwise, will be treated as a disqualification for the post."

to our contributors

- SCIENCE REPORTER welcomes articles of absorbing interest on science and technology. Contributions
 published in the Journal will be paid for.
- Articles should be sent to the Editor, SCIENCE REPORTER, CSIR, Rafi Marg, New Delhi-110001.
- The form and manner of presentation of the subject should be easily understandable to the undergraduate level.
- The length of the article, written exclusively for the Journal, may be about 2500 words.
- The matter should be typewritten, double space on one side of the paper; the original and a carbon copy are to be sent.
- The article should preferably be illustrated; captions and legends typed separately and attached at the end of the article. Photographs should be on glossy paper.
- While quoting names of scientists, etc., their initials, nationalities and periods of research under reference should invariably be mentioned. All weights and measures should be given in Metric Units.
- A short note about the contributor should also accompany the article. The note should contain age, academic accomplishments, important assignments held, fields of research and hobbies.
- Articles or illustrations published in the Journal can be reproduced with permission of the Editor.
- The Editor reserves the right to reject even invited articles without assigning any reason.

SUBSCRIP	T	10	N
FORM			

To

The Editor
SCIENCE REPORTER
C.S.I.R., New Delhi-110001

Name Full Address (in capitals)

PIN

(Old Subscription No.)

Signature

NOTE: Please mention old Subscription No in M.O. coupon also.



VOL. 13 MAY 1976 NO. 5

260 LETTERS

262 PLANETS AND THEIR POSITIONS—JUNE 1976

MAIN ARTICLES

263 The decibel inferno
268 Negative temperature—
268 Megative temperature
268 Mega

279 The heavy metals Sunil P. Pande

284 SCIENCE SPECTRUM

Lightning and thunder understood—Holography-photography without camera—The atmosphere of Titan—Balanites roxburghii as a source of diosgenin—Male sterility and hybrid seed production—Microbodies in plants—Streptomyces and its impact—Life's energy currency—Hydration due to water—March of the spiny lobster—Some insects can cure diseases—Gars—The Loch Ness monster-a reality?

303 NEWS AND NOTES

Indo-Soviet Symposium on Embryology of Crop Plants—New atomic particle discovered—Mercury pesticides banned in U.S.A.—C.N.R. Rao elected Fellow of ACS—Dr. Tatum passes away

305 MEDICAL NOTES

New diagnostic tests for lead poisoning—Care of the club foot - Malnutrition -the cause of aggression

308 SCIENCE FOR THE YOUNG

Mathematical talent search in U.S.A. and India-Molecules that make life possible-How air-conditioner works - Camphor

316 SCIENCE AND INDUSTRY

Patient monitoring system - Zinc dust-Harmless chemical for farms

318 BOOK REVIEWS

Biomolecules: Structures, Properties & Functions—Energy for Survival, the Alternative to Extinction—Text Book of Social Medicine—Understanding Physical Chemistry

he Council of Scientific & Industrial esearch assumes no responsibility or the statements and opinions Ivanced by contributors.

cience Reporter is issued monthly.

Annual Subscription

nland : Rs. 10.00

Foreign : \$ 5.00

Editor: S.P. Ambasta Asstt. Editors: C.B. Sharma, Zaka Imam

Editorial Staff: Dilip M. Salwi, Nisha Misra Sales & Advt.: G.N. Jaswal, G.E. Salpekar

Production: V.S. Chaturvedi



Number of stars

Sir, To say that there are about 2500 visible stars on any moonless clear night is one thing, but to say that it is physically possible to count them in about 40 minutes (Believe It or not, S.R., Dec., 1975) is simply unpalatable. I would like to know whether Dr. Khan has really bothered to verify the number of stars himself. In the counting process there is a possibility of stars being counted more than once, while others may not be counted at all. Then, it will be "beyond human endurance" o simultaneously account for the number of stars setting and rising during the 40 minutes counting prec.

S.K. GURTU

Defence Science Laboratory

Metcalfe House

Delhi-110054

Rice and diabetes

Sir, I came across the interesting article Is rice taboo for diabetic? by A. Ramachandran and M. Vishwanathan (S.R., Nov. 1975). Their information that the intake of high carbohydrate, instead of low carbohydrate with high protein and ow fat diet, is good for diabetic was useful to diabetics. Thanks for the article.

I would like to know whether the amounts of protein quoted against different foodstuffs are related to their raw state or cooked form.

The authors have given the caloric values of different classes of foodstuffs rather wrong, because caloric values of carbohydrate, protein and fat are 4.1. 4.1 and 9.3 respectively. A small fraction multiplied by a big number will give an appreciable quantity. Caloric values of carbohydrate, protein and fat in Table 6 would become 1086.5, 422.2 and 418.5 respectively. The total calories would become 1927.3 instead of 1877, a net rise of 50.3 calories.

SHAILENDRA KUMAR Mamanimal, Hazipur

- The values mentioned are for the weight of different foodstuffs in their raw state.
- 2. Eventhough you are right as far as the absolute values are concerned, for all practical purposes the caloric values of carbohydrates and proteins are taken as 4 and that of fat as 9 by clinicians all over the world. This small difference of 50 calories in 1900 calories is not significant as far as dietary therapy is concerned.

A. RAMACHANDRAN

Diabetes Research Centre

52-53, Main Road

Madras

Living fossils

Sir, I read Fossils—the track sign of past (S.R., Jan. 1976). I remember that there was an article Living fossils—a challenge to evolution by Vijay K. Sharma and O.S. Singh (S.R., Jan. 1974). I will be grateful if you publish an article on living fossils (Angiosperm).

K.S. YADAVA

Botany Deptt.

D.S. College

Aligarh

Pollution

Sir, I read Know your environment by the late Dr. G.K. Seth (S.R., Jan. 1976). I am interested in insects which are a key partner in the food chain system of the natural environment. Most insects form food of the fishes, while a few of them eat fries and fingerlings of the fishes. Oil pollution is a great problem in an industrialized country. Pollutants not only damage the aquatic life, but also the interaction between them affects significantly all responses except survival of the instar larvae of the insects. The interaction between pH and phenoaffects the per cent survival of the 2nd instar larvae and the nitrogen content of 4th instar larvae (Thronton, 1975).

KRISHNA GOPA

Deptt. of Zoolog

University of Gorakhpu

Gorakhpur-273001 (U.P.

Vitamin A

Sir, Apropos of Role of Vitami A-new concepts by Nisha Bajpa (S.R., Jan. 1976), it would perhap worthwhile to point ou that not all 'vitamins' are 'vita amines'. Undoubtedly, it was thi notion which led to their nomen clature as 'vitamines'. But to emphasize the fact that they are no necessarily amines or amino acid the terminal 'e' was later with drawn. For example, even vitamin A is not an amine; it exists as alcoho (retinol) or aldehyde (retinal) and i obtained as follows:

A—carotene [2 0] → Retinal (Provitamin A) Dioxygenase reaction

Besides vision and growth, vitamin A's role are many and diverse in maintenance of skin and epithelial cells, mucopolysaccharide synthesis, maintenance of cell membranes and lysosomes integrity maintenance of colour and periphera vision, maintenance of adrenal cortex and steroid hormones syntheses and probably resistance to infections It also activates some enzyme systems.

Vitamin A deliciency leads to blockage of sebaceous glands and hair follicles of skin and lacrima glands of eye with horny plugs o reratin resulting in xerophthalnia (the earliest clinical sign), keraomalacia and ultimately panophthalnitis and destruction of eyeball.
The earliest symptom of vitamin A
deficiency, however, is night-blindness (nyctalopia). It is interesting to
note that in vitamin A deficiency
there is increased susceptibility to
athyrism. In India, blindness of one
nerson out of every four may be
raced to vitamin A deficiency.

P.K. AGRAWAL G.S.V.M. Medical College Kanpur

Killer khesari

Sir, Apropos of Killer khesari and is neurotoxin (S.R., Jan. 1976), I would like to add another interesting inding regarding the harmful effect of khesari seed. Recently, S. Chakrasarti (1975) from Calcutta has resorted (Curr. Sci., 5, Sept. 1975) that he 'dal' of khesari not only causes different neurological symptoms, but also acts on the chromosome complements of certain mammals.

However, it is now necessary to ind out whether the seeds of khesari could produce similar harmful effect on human beings.

R. PRASAD
P.G. Deptt. of Biology
Berhampore University
Orissa

Plants and pollution

Sir, Plants too held responsible for collution by Zaka Imam (S.R., Dec., 975) was quite interesting. The general belief that plants, by absorbing carbon dioxide of the atmosphere and releasing oxygen into it, act as gents to reduce the pollution of the

environment is reversed by the discoveries reported in the said article. The physiology of this phenomenon, though precise, was well described, A recent survey has indicated that some plants like Croton sparsiflorus, L. (Euphorbiaceue) and Ipomea sp. (Convolvulceae) are common in areas where industrial and other effluents contaminate the environment. Further, in a critical study an affinity of these plants with this type of environment was found. It is clear that these plants have well adapted themselves by absorbing toxic gases of the polluted places. The cultivation of such plants may be helpful in places like an industrial complex or the thickly populated urban areas.

M. MADHUSUDANA RAO

Botany Deptt.

Post-Graduate Centre

Osmania University

Warangal (A.P.)

Tissue culture technique

Sir, There is a gross mis-statement ascribed to me in the write-up on p. 178 of S.R., March, 1976: "For 3-4 years botanists in the country were not ready to believe in the 'tissue culture technique' which I discovered in 1967". I never said this. All biologists know that I did not discover the technique which was well established long before 1967, and we merely used it as a handy tool

S.C. MAHESHWARI Professor of Botany Delhi University

Suggestions

Sir, I am a regular reader of S.R.. New maths and teaching of

Shyamal K. Majumdar (S.R. March. 1975) was informative and useful both to school teachers and students. The article The history of non-Euclidean geometry by Jyotirmoy Hui (S.R. Nov. 1975) also impressed me. As a student of science and lover of mathematics, I would like you to publish more articles on mathematics.

SURVIT BHADURI Lower Badjana Colliery Nusbachatti, Dhanbad

11

Sit, I have been reading S.R. for the past six months. As a science student, I find it vers in tall in my studies.

I would like an article on organic evolution. It should describe the history and distribution of animals during various eras after the appearance of life on earth

Also, please start a separate section entitled 'Questions and answers'.

> GOUTAM BANIRII 37, Banerji Pana Road Behala, Calcutta

> > 111

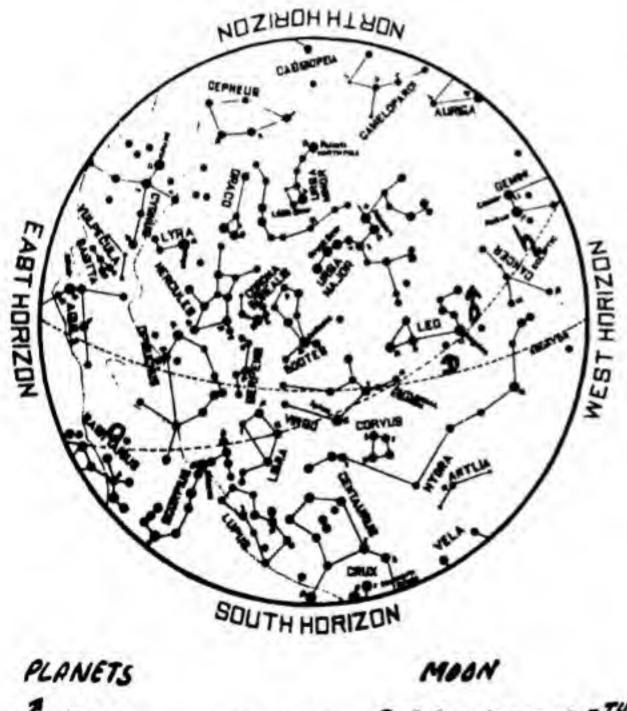
Sir, I read S.R., Nov., 1975. I am a student and I find it very helpful in my studies.

Anti-transpirants reduce water needs in agriculture and Heart lung machines (S.R., Nov., 1975) were impressive articles. Please publish an article on evolution of man or theories of evolution.

> MUKFSH TAI WAR Dayal Bagh Road, Agra

Planets and their positions

JUNE 1976



& MARS

MAGNITUDES D FIRST QUARTER 5 TH

The moon

FULL moon occurs on 12th at 9-45 a.m. and new moon on 27th at 8-20 p.m. I.S.T. The moon passes about six degrees south of Saturn on 2nd, seven degrees south of Mars on

3rd, very close to Jupiter in the early hours of 24th, about one degree south of Mercury in the early hours of 26th, and again about six degrees south of Saturn in the evening of 29th. The lunar crescent becomes first visible after the new moon day

in the evening of 29th.

The moon is at perigee or nearest to the earth on 10th and at apogee or farthest from it on 21st.

The sun is at the summer solstice on 21st.

The planets

Mercury (Budha), a morning star, rises about an hour before sunrise during the month. It becomes direct on 2nd and is at the greatest western elongation of about 23 degrees from the sun on 15th. It pases about three degrees north of the star Aldebaran (Rohini) on the 22nd. It is in Taurus (Vrisha). Its visual magnitude varies from +1.9 to -0.6.

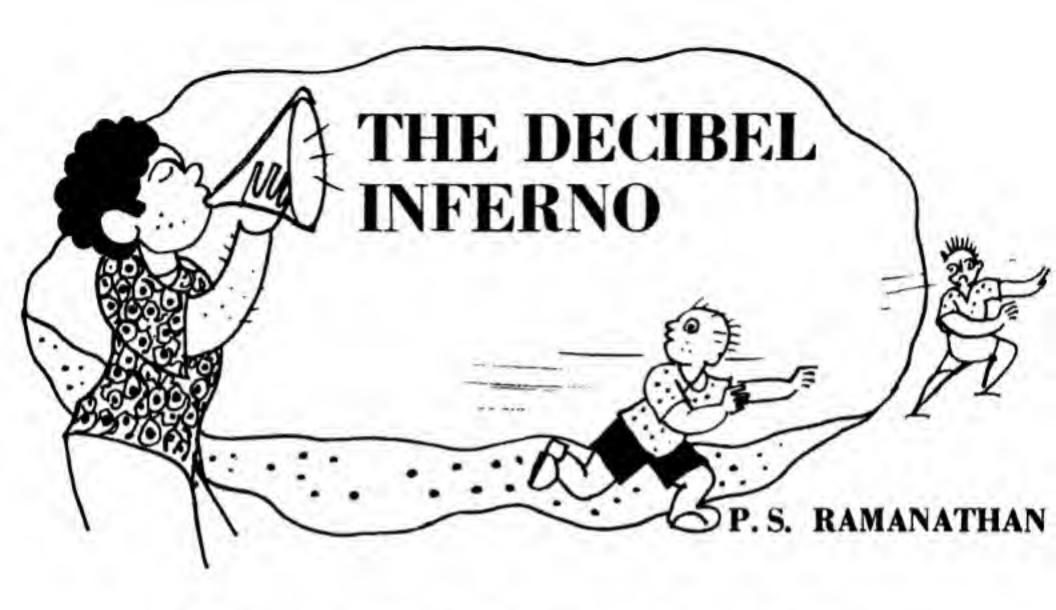
Venus (Sukra) is too near the sun to be visible during the month. It is in superior conjunction on 18th. It moves from Taurus (Vrisha) to Gemini (Mithuna).

Mars (Mangala), visible in the evening sky, sets about two hours before local midnight during the month. It moves from Cancer (Karkata) to Leo (Simha). Its visual magnitude is about +1.8.

Jupiter (Brihaspati), visible in the morning sky, rises about one and a half hours before sunrise during the first half of the month and about two and a half hours before it during the second half. It is in Aries (Mesha). Its visual magnitude is about —1.6.

Saturn (Sani), visible in the evening sky, sets about three hours after sunset during the first half of the month and about two hours after it during the second half. It is in Cancer (Karkata). Its visual magnitude is about +0.5.

(Source: Nautical Almanac Unit of the Meteorological Office, Alipore, Calcutta-27)



The bel is a measure for comparing the intensity of sound. Decibel is the tenth part of a bel. Inferno means hell. So the "hell created by unwanted sound" is what this article is about

COUND is always associated with some kind of motion such as walking, running, vibration, etc. As sound is related to motion and motion to energy, it is logical that sound is a form of energy. We cannot hear sound emanating from an object, such as a vibrating bell, if it is situated in vacuum. This is because sound requires a medium, such as air, to reach our ears. The vibrations of a bell move the medium which, in urn, activates the sound sensitive part of the internal ear. Transfer of sound energy occurs in form of waves.

We all have seen waves in disturbed water. The lowest and highest coints in a wave are named troughs and crests, respectively. The distance between identical successive points such as neighbouring crests or troughs is called a wavelength (Fig I). The height of a crest or the depth of a trough is called an amplitude. The rate at which the disturbance moves is called speed and the number of disturbances passing a given point per unit time is called frequency. The familiar relationship connecting these three quantities is:

Speed = wavelength × frequency.

The audible range of frequency is

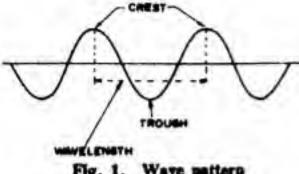
20 - 20000 cycles per second.

There is a major difference between a sound wave and a water wave. The sound wave does not manifest itself as crests and troughs. It is essentially a succession of compressions and rarefactions (expansions) that disturbs the normal density of the medium through which it propagates. Waves of this type are called "elastic waves". Such a wave pattern is generated when the bump on a rotat-

ing wheel is made to hit periodically the end of a spring (Fig. 2). The resulting compressions (and the expansions which accompany these compressions) travel along the spring with a speed determined by the properties of the spring and not by the rotation of the wheel.

A balloon or bladder filled with a fluid snaps back when it is squeezed and subsequently released. This is because fluids are springly substances. The elastic sound wave can, therefore, be propagated through these media. It is obvious that work has to be done by the media to hit out the compressions produced in them. This indicates that sound is the transmitted energy.

The speed of sound in air under normal conditions is about 335.25m, second. The tone or pitch of a given sound is decided by the frequency of



Wave pattern

the waves that produce it. Unlike electromagnetic waves (light rays, X-rays, gamma rays, etc.), the energy of a given sound is not determined by either frequency or wavelength or speed. The energy depends on the work done to create disturbance (in terms of amplitude). The sound of a single siren, for example, is identical to that emanating from a group of identical sirens so far as its wavelength, frequency and speed are concerned. The frequency of the sound depends on the type and characteristics of the siren, while the speed of sound is a property of air and not of the siren. It is, however, obvious that a group of n sirens consume "n times" the power consumed by a single siren. The sound energy is naturally "n times" greater than that produced by a single siren. Sound energy is related to loudness, but the two are not the same. This aspect is amplified in

Table 1. Londness of sound generated by several sources

Source	Sound level in dB (approximate)	Sound level as understood by common man
Soft whisper	25	Very quiet
Ordinary conversation	60	Moderately loud
Vacuum cleaner	70	do
Food blender	85	Very loud
Motor cycle (about 25 feet away)	90	do
Jet plane, (about 100 feet away)	105	Uncomfortably loud
Thurderclap	120	do
Jet plane take off	150	Painful
Rocket engine	180	do

a subsequent section.

What is noise?

Noise has been defined as "unwanted sound". A typical example is the unpleasant and unbearable music emanating from hard-throated persons. Noise obviously causes considerable hardship, annoyance and sufferings to those who are subjected to it. Diametrically opposite to this is the pleasant music sung by reputed singers.

It is more appropriate to call sound a "noise" only when it is not wanted or liked. A particular sound may be music to one but noise to another; pleasant when soft, but noise when loud. Of all the attributes

that distinguish noise from wanted sound, loudness is generally considered as the most significant.

The decibel scale

Loudness and energy are interrelated. The former has a remarkably wide range. For example, a very soft whisper of a human voice has a loudness equivalent to only 10-9 watt. A piano has been rated as loud as a 0.1 watt siren, and a large rocket engine as loud as a 107 watt siren. From these examples it is apparent that loudness demands the use of inconveniently small and large numbers. This problem is overcome by choosing a logarithmic scale for expressing loudness. The unit "Decibel" has been defined as follows:

Loudness in decibels = 10 × log10 (power of a given sound/power of a barely audible sound)

On the basis of this scale, the softest audible sound has a value of zero decibel. The power of an ordinary conversation has been estimated to be about 10° times greater than that of the faintest sound. The sound power of the conversation in decibels then works out to be 60 decibels (dB).

Table 1 indicates the loudness of sound generated by several sources in terms of dB units, and also in terms of the common but nonscientific "quiet", terminology such as "loud," "very loud", etc.

Measurement of sound power

A microphone converts sound into



"They are afraid of naming the main source of noise pollution"

electrical power. On this basis, a "Decibel meter" reads out (in watts or decibels) the sound power. It is, however, insensitive to pitch. Humans have introduced certain subjectivity into ratings sound. People generally tend to high-pitched rate sounds louder than low-pitched ones of the same power. Consequently, a scale of loudness, as judged by people, would be frequency-dependent. Therefore, it would be different from that of the decibel meter. To reconcile this difference between man and machine, a subjective loudness scale has been developed. In this scale, comparison is made of any given sound with that of a pure tone having a frequency of 1000 beats (or cycles) per second. For example, if the subjective loudness of a pump working at a distance of 30 feet is to be evaluated, a given person is subjected to a selection of pure 1000 cycle sounds of different loudness and asked to pick the one just as loud as the working pump. Let us assume that he chooses an 80 dB sound as the equivalent sound. this choice represents typical or the average response of many people, the pump at 30 feet is said to have a "loudness level" of 80 phons, even though its own decibel rating in terms of sound power might be different (say 82 dB). The "phon" is therefore a unit of subjective loudness which is matched with the decibel scale for a pure 1000 cycle sound.

Effects of noise

A noise can (a) interfere with communication, (b) diminish hearing, and (c) affect health, and even behaviour. It prevents us from what we want to hear and enjoy. It is easy to visualize that a conversation can be carried on in whispers in a still place, while one has to shout to make sense in a noisy factory.

Exposure to loud noise for a fairly long time can produce permanent hearing loss.

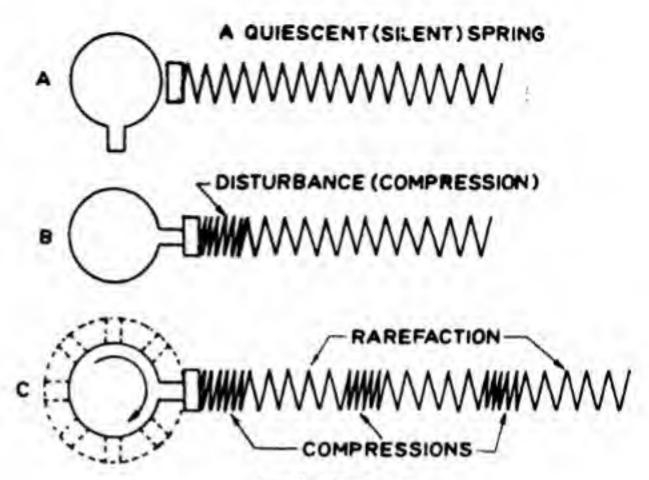


Fig. 2. Elastic waves

Inhabitants of cities are generally subjected to a high level of noise which gradually deafens them, as compared to those living in quieter towns. For example, the din at the railway terminii in Bombay often rises above 70 dB, the level considered "comfortable" for the human car. A survey conducted in various parts of the city has shown that the noise level in many places is as high as 90 dB or even more. This is definitely above the comfortable level. The hooting of trains is a strain on ear because the level of noise rises to 130 dB, decreasing to 90 dB at a distance of about 30 feet. The noise level inside a running bus is in the range of 60-70 dB. The din and noise of crackers during Diwali (which can more aptly be called the "festival of sound" instead of "festival of lights") are so loud and unbearable that it is necessary to think seriously about the health hazards accompanying an uncontrolled increase in the deafening noise associated with this festival. It is high time that some sort of legislation is introduced to check this menacingly increasing health hazard.

Noise levels above 80 dB are capable of producing permanent hearing loss. The effect is faster for louder noises and it is somewhat dependent on frequency. Occupational noise is deafening many millions of workers. Listening to deafening noise has aptly been compared to staring at the sun which causes blindness.

Sound level of about 120 dB can effectively saturate our sense of hearing. Greater sound powers are, therefore, not perceived as being louder, though, they may be more harmful. Prof. Graul of Marburg. University Hospital for Nuclear Medicine has recently emphasized that even short term exposure to 150 dB can lead to deafness. A sound reading of 155 dB can burn skin while a sound of 180 dB can even cause death. Sound weapons developed by the super powers aim at producing more than 200 dB.

In a complicated system of a living organism the effects of stress of disturbance follow intricate pathways that may be difficult to elucidate. Contrary to common belief, loss of hearing is not the most serious consequence of excessive noise. The first effects are anxiety and stress reactions or in some extreme cases, fright. These adverse reactions are coupled with a

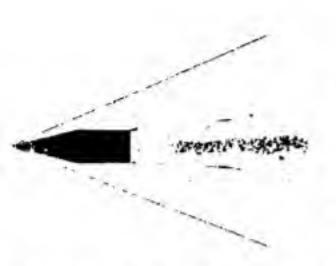


Fig. 3. A typical 'wave' of a supersonic projectile

change in hormone content of the blood which, in turn, produces body changes such as increased rate of heart beat, constriction of blood vessels, digestive spasms and dilation of pupils of eyes. As a logical consequence of such stimulations, many undesirable long term effects may be experienced though it is not easy to assess them. Available evidences suggest that in animals it damages the heart, brain and and produces emotional liver disturbances. It is also well-known that the overall working efficiency goes down when noise level goes up.

SST and the sonic boom

The terms "subsonic" and "supersonic" are used to denote respectively the velocities of objects moving slower and faster than sound. The SST (supersonic transport) is a passenger aircraft that travels faster than sound and at much higher altitudes than subsonic air planes. The undesirable by-product of the higher power needed for achieving higher speed is the accompanying noise level. Residents near airports experience severe noise problems when planes take off and climb up rapidly, although the speeds in these cases are subsonic. The SST is a source of noise of very high magnitude because (a) its engines are comparatively smaller in diameter, and (b) its speed is very high. The noise from a jet exhaust increases enormously for a given engine thrust as the jet-diameter is reduced and its speed increased.

Supersonic speeds are usually measured in Mach numbers (after Ernst Mach, a physicist who made important contributions in the field of sound) defined as follows:

Mach number=Speed of object/ speed of sound.



"The Minister is in the town to campaign against noise pollution

The "sonic boom" is a significant effect experienced when the SST reaches supersonic speed during flight. It is essentially a high energy air wave created by supersonic aircraft. The concept can be understood by visualising the rapid movement of a speed boat in water. As its speed is greater than that of the waves it generates, the latter are left behind during its onward motion. The wave energy is, moreover, being continuously reinforced by the forward movement of the boat. This results in the production of a high energy wave called a "wake" that trails the boat in the shape of "V". This naturally slaps hard against the shoreline or other vessels. The tip of an exactly similar kind of "wake" moves forward with SST (Fig. 3) while the sound itself moves away from the wake at its usual speed.

The sonic boom sounds like a loud, close thunderclap. It is an unnerving experience to get struck by a sonic boom. The duration of the boom is only for a fraction of a second in which the pressure rises above normal and then falls below normal. Depending on the power it generates, the boom can rattle windows or shatter them. In some extreme cases it can even destroy buildings. The sonic boom commences when the aircraft breaks the sound barrier, and thereafter trails the aircraft as long as its speed is supersonic. The energy and the consequent destructive effects of the boom increasewith the increase in speed of the aircraft (ie, increase in Mach number at a given altitude).

The Anglo-French "Concorde" and the "TU-144" planes of the USSR are supersonic passenger aircraft which have, no doubt, very remarkable technical qualities. In the test flights conducted recently, the Concorde has attained speeds approaching 1400 miles an hour and cruised at 60,000 feet, almost twice the height at which the subsonic jets fly.

It has been stated that the SST on the runway would sound like 50 ordinary jets taking off at the same time. Based on the noise of one jet plane, if one defines a new decibel scale, the SST would be 17 decibels louder than one jet plane. Experiments on noise judgment show that a sound 17 dB louder than another is normally judged "three to four times" as loud.

Need for a national effort

Now the question that arises is: What should we do to face the increasing evil of noise pollution?

In the present age of industrialisation noise has become not an occasional adjunct but a permanent part of man's life. Dr. Alan Bell, associated with the World Health Organization, has recently pointed out that noise is much more than an occupational hazard. It is a public nuisance and a danger to mental and physical health.

In our country comparatively little attention is paid to control noise. The Government must take a serious view of the increasing noise pollution, assess the correct situation within the country, and take appropriate measures to protect workers from the hazards of noise. One of the difficulties encountered while assessing noise pollution comes from the fact that it is difficult to distinguish clearly between hearing impairment due to advancing age and impairment due to occupation. Difficulties also arise when employers fear that investigation of the problem may promote litigation and legislation. Occasionally, difficulties arise from the attitude of the labour organizations as well.

The potential cost of noiseinduced hearing loss to industry is greater than for any other occupational disease. Hearing impairment, worker's compensation, reduced output, increased accident rates, communication difficulties, etc., are some of the important factors to be taken into account while considering cost.

In the past, there has been a general lack of interest in this area. Until recently, suitable and accurate methods of measuring noise level were not available. What is extremely important is that the awareness of the existence of such a major problem must be created even before devising concrete measures to control the hazard. Industrial indifference can be reduced if doctors inquire into the occupations of patients with hearing defects, if factory inspectors encourage management to seek advice about noisy processes, and if governments develop comprehensive occupational health services equipped for noise evaluation. Insurance companies can also play a vital role as reduction in working hazards lowers accidents and insurance costs.

Industrialists must take noise control with the same seriousness as control of toxic fumes in the atmosphere is taken. It is important to educate the public and industrial managements to regard noise as a possible cause of nuisance.

However, no national noise-control programme would be regarded as complete unless it includes research. Medical research laboratories must take up the study of problems on noise in all its seriousness. Codes and specifications must be evolved. Appropriate legislative measures must also be taken to protect the public and punish the offenders.

Noise control

Metropolitan Transport Project (Railways) is making efforts to study noise levels in different parts of Bombay and to see how rapid transport facilities can be provided without contributing to the increase in the present noise levels. Laying of ballastless tracks may lessen noise levels.

The main methods to control noise are: (a) to reduce the source, (b) to interrupt the path of transmission, and (c) to protect the receiver. Reducing the sources that generate sound is obviously the most straight forward approach in this direction. For example, the number of noisy trucks, motor cycles, etc., plying through residential areas can be reduced by legislation. There are, however, obvious limitations to this

(Continued on page 271)



"I am really confused -which of the two sources of the noise pollution will be easier to control?"



The concept of negative temperature is as real and meaningful as of positive absolute temperatures

F we heat a body, or technically a system, the usual result is rise in temperature. It is interesting to inquire whether the temperature rise would continue with the pouring of energy into the system. The answer to this question, as given by classical thermodynamics, is in the affirmative. It claims that a system can be heated, in principle, to an infinite temperature. So, now what will happen if more energy is supplied to a system already at infinite temperature? The answer is "the system would be at a negative absolute temperature"! Though quite interesting, yet this answer is puzzling.

Could we really heat a system beyond infinite temperature? Surprisingly, the answer is yes; but not in the usual sense. We can "heat" a system to a thermal state which is hotter than its thermal state at infinite temperature. However, the systems that can be heated upto negative absolute temperatures differ from the ones we generally encounter.

The main difficulty in understanding the concept of negative absolute temperature is posed by our notion of infinite temperature. By infinite temperature we usually understand the highest imaginable temperature, and here we are wrong. The temperature of a body is a sort of index that suggests its thermal state. Thermal states of a body can be best described by the distribution of the constitutent particles among their various energy levels.

Two kinds of systems

We give below a number of examples that we encounter in everyday life and which resemble the Maxwell-Boltzmann distribution of particles among the energy levels of an individual particle:

(i) Consider the salaried section of the society. The higher the salary, the fewer number of posts in any organisation. (ii) Consider a race. The longer the distance to be covered in a period, the fewer the racers who would succeed. (iii) Consider now the distribution of students who pass through an examination. The higher the pass marks, the fewer are the students who get through. (iv) Another example is the distribution of particle density (that is, the number of particles per cm²) of a gas in a gravitational field with respect to height. This is given by:

 $n = n_0 e^- \Sigma_p/kt$; ($\Sigma_p = mgz$)...(1) In this equation, n_0 and n are respectively the particle densities at the heights $z=z_0$ ("ground level") and z=z; g is the acceleration due to gravity; k is the well-known Boltzmann constant and T is the thermodynamic temperature of the gas. Σ_p is the potential energy of the particle at the height $z=z_0$ on sidering $z=z_0$ at zero.

Let us now consider a quantum system. A quantum system is a system which can take on only a discrete set of energy levels. Non-quantal systems, i.e., the classical systems, can take on any value within a certain range. An example of a classical system is a gas in a container in which kinetic energy of a molecule might take on any value depending on the temperature of the gas. Thus, kinetic energy of the molecules is not quantized. However, the excitation energy of such molecules is a quantal property. It can assume only certain discrete energy values. The above description shows that the same gas in the container has two different distributions: one for the kinetic energy and one for the excitation energy. The distribution of kinetic energy among the molecules is given by Maxwell's velocity distribution

$$\delta n = 2 \pi n \left[\frac{1}{\pi k T} \right]^{3/2} - \Sigma/kT 1/2$$
 $\epsilon \cdot \Sigma \cdot \delta \Sigma \cdot \cdot \cdot \cdot (2)$

Here an is the number of molecules having the kinetic energy lying in the range ax; n is the total number of molecules constituting the gas at the temperature T.

The distribution of molecules,

i.e., the energy levels of the molecules or atoms)—which are discrete s, however, quite different from the Maxwell's velocity distribution law, but identical to the equation (1). That is:

n₁=n₀e Σ_1/kT (3) In equation (3), n₁ is the number of molecules or atoms in the "i" energy level; n₀ is the number of molecules or atoms in the ground level; Σ_1 is the "i" energy level of a molecule or an atom, and T is the thermodynamic temperature of the gas; it has the same meaning as in the equations (1) and (2).

From equation (3), we find that the distribution of molecules among their energy levels is such that with increase in the energy value the number of molecules occupying that very energy level decreases. In other words, the higher the energy level, the lower is its population.

We now heat the system under consideration. We find that the temperature of the system rises and the distribution of molecules with respect to their kinetic merely shifts towards higher energy. The peak of the velocity distribution curve becomes a little broader; but no remarkable change in the distribution takes place (see equation (2)). The case is, however, completely different in respect to the distribution of the molecules in their energy levels. As is evident from equation (1) or (3), the number of molecules occupying lower energy levels begins to decrease with the rise of temperature. The systems, the constituent particles of which obey the distribution given by the equation (3), can be "heated up" to attain negative absolute temperatures.

Negative absolute temperature

An atom or a molecule has a large number of energy levels. It can absorb certain discrete amounts of energy, and become excited. An atom or a molecule can remain in the excited

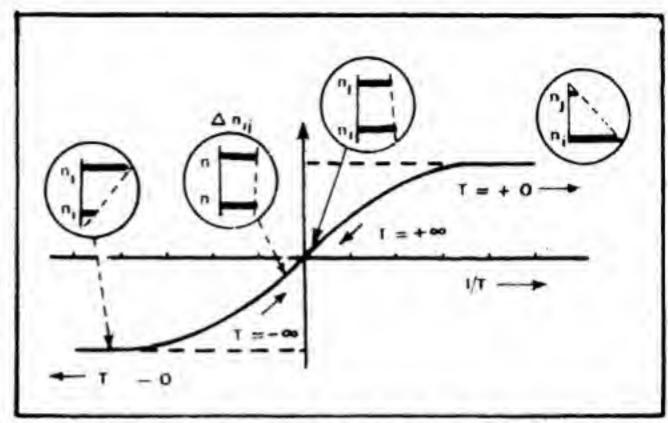


Fig. 1. variation of population difference, $\triangle n_{ij} - n_i - n_j$, in a two-level system with respect to temperature.

state for some time (this period is called the life-time of that particular excited state); thereafter, it radiates a certain amount of energy and comes down to its lowest energy state—the ground level. An atom or a molecule can be excited to any of its energy levels depening upon the quantum of energy it absorbs. This can be better understood by comparing a train with an atom and a passenger with an electron. A train has different classes; first, second, and third, similar to the energy levels of an atom. A passenger can occupy a seat in any class by buying the suitable ticket. His occupying a seat in any class resembles the atom's transition from the ground state (platform) to any of its higher energy states. An atom or a molecule can make upward and downward transition between any two of its energy levels like a trainpassenger. For simplicity, we shall consider only two energy levels of an atom. In practice, this is achieved by selecting the suitable energy levels of certain atoms, molecules or ions, e.g., argon ion, helium-neon mixture. etc.

Let us now consider the distribution of the constituent atoms or molecules between two energy levels Σ_1 and Σ_2 ; Σ_1 being less than Σ_2 . From equation (3), it is evident that the population ratio (number of

particular level is called the population of that level), n₁/n₁ will be given by

 $n_1/n_1 = e^{-(\sum_1 - \sum_i)/kT}$ (4) where n_1 and n_1 are respectively the population of the higher and the lower energy levels of an atom.

Since our system is prepared in such a way that all the constituent atoms or molecules occupy either of the two levels Σ_1 and Σ_2 , we find from equation (4) that increase in temperature results in the increase of the population n_1 of the higher energy level, Σ_2 . If we continue to pour energy into the system its temperature continuously rises and, therefore, the population ratio, n_1/n_1 , also correspondingly increases. This means that



"Well-known for his negative attitude in his life, I am not surprised that he finds research on negativetemperature so absorbing"

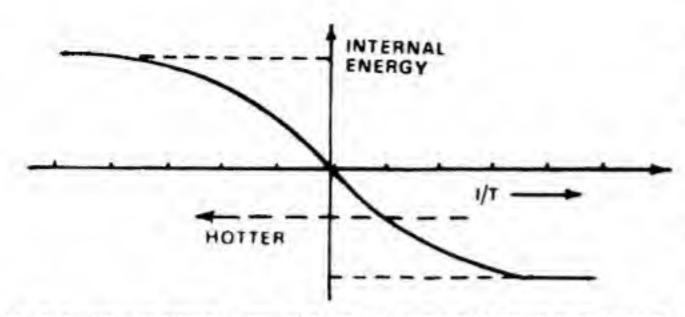


Fig. 2. Variation of internal energy of a two-level system with respect to temperature

evel \$1at higher tem *ratures (Fig. 1). At infinite temperature, T=00, the opulations of the lower and the righer energy levels become equal. t may be remarked here that though he temperature of the system has ecome infinite the energy of the ystem still remains finite. $\Sigma_1 + \Sigma_1$; $n (= n_1 + n_1)$ being the total umber of atoms or molecules comrising the system, as is illustrated in ig. 2 (the zero level for the energy evels has been chosen midway betreen the two energy levels). If we still our energy into our system, its nergy becomes greater than its

nergy at the infinite temperature.

the particles occupying the lower energy level \$1 at lower temperatures.

go on occupying the higher energy



"Negative temperature is no myth.
really have it whenever I have to
sturn home at late hours"

system at infinite temperature! This further increase in the energy of the system demands that the higher energy level be more populated than the lower In other words, populations of the levels have been inverted. Our system with inverted populations may be compared with a train in which first class passenger are more than the second class passengers. This distribution of the passengers is somewhat unusual, but it is as meaningful as the more usual one in which the number of second class passengers is far more than the number of first class passengers. The systems with inverted populations, though not encountered usually, are physically as meaningful as the systems characterized by the Maxwell velocity distribution (2). To describe the thermal states of the systems with inverted populations, one has two options: (i) to retain the Maxwell-Boltzmann distribution and assign negative values to the temperature, T or (ii) to find out a new distribution. The first alternative is feasible and, therefore, has been accepted the world over. In view of the aforesaid statements, the equation (3) could now be taken to define the temperature of a system. This definition, which allows temperature to assume negative values, also does not contradict the thermodynamic concept of temperature; instead, it extends the scope of the definition.

All systems cannot be heated to attain the negative values of temperature. Negative temperatures arise in

systems which have bounded sets of possible energy levels. They are, therefore, associated with internal atomic motion which can take on only a discrete set of energy values, i.e., they are quantized, unlike the kinetic energy of an atom or a molecule which can assume any value within a certain range. The external atomic motion is, as is quite well known, always associated with the positive absolute temperatures. The internal atomic motions-the transitions of electrons between different energy levels-really form a separate and essentially an isolated thermal system; likewise, the external atomic motions also form a separate and isolated thermal system. These two systems, though they mutually interact, can however be kept separated from each other, i.e., during a certain period there would not be any energy exchange between them. These two systems, therefore, have quite different distributions and hence different temperatures. The number of the atoms in the higher energy state may far exceed the number of atoms in the ground state; such a distribution, according to definition (3), would be characterized by a negative value of the temperature. In contrast to the above distribution, the distribution of the atoms in the various energy groups would be given by the Maxwell velocity distribution (2). Thus the gas in a container may be associated with two entirely different temperatures! The internal and external atomic motions constitute, as already mentioned, two different thermal systems and hence can be assigned two different temperatures. These systems, the internal and external atomic motions, behave quite differently, and this is evident from the fact that they are described respectively by the quantum and the classical mechanics. Usually the time taken by these thermal systems, to come to their equilibrium, is different. Since interactions between these systems always take place in the absence of special efforts to keep them isolated, they finally come to an

equilibrium, and the temperatures associated with these thermal systems attain a common value corresponding to its final mutual equilibrium.

An interesting example of the coexistence of negative and positive temperatures in the same body is provided by the lasering ruby crystal. The system, comprising of the excited and unexcited atoms, constitutes a system at a thermal state corresponding to a negative absolute temperature, while the crystal as such is a system which is at a positive absolute temperature. In a lasering ruby crystal, the number of excited atoms exceeds the number of unexcited atoms and hence this distribution of atoms between the

higher and the lower energy levels would be given by the distribution (3) only at a negative temperature. abbreviation ("Laser" is an for the 'light amplification by stimulated emission of radiation'). The two thermal systems in the lasering ruby crystal can be compared with a heater placed inside a refrigerator. The system comprising the internal atomic motions has more energy and hence, is hotter than the ruby crystal as such. In other words, the energy associated with the internal atomic motions is larger than that associated with the external atomic motions

The concept of negative absolute

the studies of lasers and masers.

Further reading

- Zemansky, M.W., Temperatures, Very High and very Low, Var Nostrand-Reinhold, Princeton, New Jersey, (1964).
- Siegman, A.E., An Introduction to Lasers an Masers. McGraw-Hill Book Company, New York. (1971), pp. 184-188.
- 3' Purcell, E.M. and Pound, R.V., A Nuclear Spin System at Negative Absolute Temperature, Phys. Rev., 81, 279, (1951).

DECIBEL INFERNO (Continued from page 267)

type of solution. Even if one is unable to accomplish reduction of such sources, efforts can certainly be made to reduce noise production. Proper oiling of the wheels, redesigning of the machinery, etc., can be mentioned in this connection. It should not be very difficult to modify technological approaches, so as to accomplish the objective of generating only a lower noise level. Procedures and schedules of work can also be changed to reduce annoyance to people working and living in an area.

Many materials, like wool, vibrate very inefficiently and, therefore, absorb sound energy, converting it into heat, the magnitude of which is very small. Sound absorbing media, known as acoustical materials, have been developed and used extensively. Mufflers can be made use of to interrupt the sound waves mechanically. Attempts can also be made to deflect the sound away from the receiver, e.g., mechanically directing jet exhaust noise upward instead of directing it downwards.

Ear plugs or muffs reduce the noise and protect the receiver. A combination of the two is reported to reduce sound by 40 to 50 dB. This will make a jet plane sound no louder than a vacuum cleaner. The jobs which are to be carried out in noisy environments must compulsorily have the facility of shift system. Such protections can certainly reduce, to a significant extent, the hazards generated by noise pollution.

Further reading

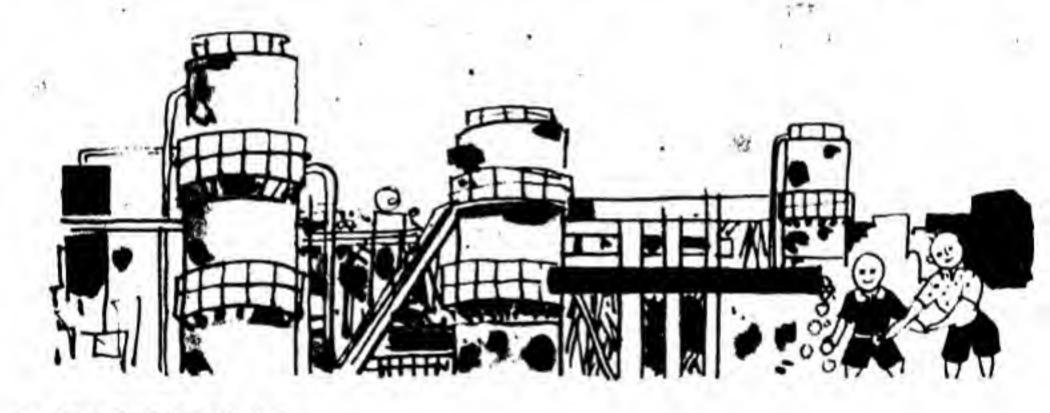
- Kryter, K.D., The effects of noise on man, Academic Press, New York, 1970.
- Bell, Alan , Noise an occupational hazard and public nuisance, WHO, Geneva, 1966.
- Schilling, R.S.F., Modern trends in occupational health, Ch. 17, Butterworth & Co. (Publishers) Ltd., 1960.

WORLD nutrition problem is essentially a question of proteins. At present roughly half the people in the world have a poorly balanced diet that retards normal growth. The main deficiency in their diet is animal protein; they live principally on grains and tubers. The diet may supply enough calories but contains inferior proteins—lacking in certain essential amino acids such as lysine, etc., that are present only in animal proteins. The peoples of Europe, USSR, and North America, with a favourable climate

Proteins from petroleum may solve world's food shortage

will need to produce 35 million tons more protein every year to meet the demand. Of this only 15 million tons will come from conventional agriculture. To meet the anticipated deficit, science is opening a new source: proteins from petroleum.

The process of making proteins from petroleum was discovered by French chemical engineer Alfred (carbohydrate), the medium for the fermentation usually consists of the carbohydrate in a water solution, soluble mineral and organic compounds containing nitrogen, phosphorus and potassium. Certain trace elements and growth vitamins are also added. A flow of air is bubbled through the liquid to provide oxygen and maintain a good



PROTEINS FROM PETROLEUM

M. K. SHARMA

and due to the development of animal husbandry, have a diet based largely on meat and fish. Not so fortunate are inhabitants of the earth's tropical regions. As the undernourished countries grow in population, the inadequacy of their diet, and particularly the protein deficiency, becomes more pronounced. Kwashiorkor, the deadly protein deficiency disease, kills tens of thousands of children every year in Asia and Africa.

The way the present world population is on the increase, experts predict that by the year 2000 we Champagnat in 1958 at the Lavera refinery near Marseilles (in France) under British Petroleum Company. The production of proteins by microorganisms from carbon-containing compounds is not a new idea. For many years, the yeast fungi have been grown on carbohydrates (mostly molasses) and they produce vitamins and proteins, comparable to those of animal origin. Champagnat showed that hydrocarbons, instead of carbohydrates, could be employed as the basic medium for the growth of microorganisms.

When yeast is grown on sugar

mixture of the materials throughout the fermentation vessel. The temperature and acidity are also carefully controlled for maximum reproduction of the yeast cells. Eventually the cells are harvested by centrifuging or filtering them out of the medium. The cells are then washed and dried and so become available in solid form as a food stock containing 50% protein. With a flavour added, the stock has been used for a variety of prepared foods, from soup to ice cream.

There are certain difficulties in growing yeasts on petroleum (hydroarbons). One is the insolubility of hydrocarbons in water. The oily hydrocarbons can be mixed in the water medium only in suspension. To keep the oil droplets well discreted throughout the medium, it must be stirred vigorously.

Another major difficulty is the greater need for oxygen. Whereas sugar molecules contain 50% oxygen, hydrocarbon molecules have no oxygen. Consequently, the oxygen supply delivered to the organisms by the bubbling of air through the medium must be at least three times greater on a hydrocarbon substrate than on a sugar substrate. Moreover, because this results in a threefold increase in the cell's output of heat, a cooling system is required to control the temperature of the medium.

These disadvantages are offset, however, by an important advantage. As all the oxygen required by the cells is supplied by the air, its consumption from the carbon-supplying substrate is correspondingly reduced. The rate of production of yeast is twice as great on hydrocarbon as it is on sugar:

under favourable conditions a kilogram of hydrocarbon should produce a kilogram of yeast, whereas a kilogram of sugar yields only half a kilogram of yeast.

Champagnat observed that microorganisms could be grown efficiently on fractions from crude petroleum rather than on the pure synthesized hydrocarbons, and found that most favoured and productive fraction on which yeasts could be grown is gas oil-a fraction between kerosene and lubricating oil. It has been found that for different petroleum fractions there are different species of microorganisms which are most efficient in turning them into proteins. The species of organisms also differ for the kind of proteins they produce. By selection and genetic breeding of the organisms, it may be possible to make proteins to order. The range of possibilities for creating proteins is wide - much wider than through agriculture or animal husbandry.

For the production of protein from petroleum, the medium is similar as used in growing of yeasts on sugar, except that oil is substituted for sugar. Nitrogen is added to the medium in the form of ammonia salts; phosphorus and potassium are supplied as general fertilizer Trace elements and growth vitami are also added. After terment. tion, washing, drying and purification, the yeasts become odourless. virtually tasteless. cream coloured powder that looks like flour. It has less odour than yeasts grown on sugar. The new product of the organisms, called "toprina", is about 65", protein whereas soyabeans are 45%.

Protein

Apart from the protein "toprina", we get another important byproduct from this process. The organisms feed mainly on the wax in the paraffinic oil, i.e., they deparaffinize the oil. With the wax removed, the oil is more fluid and becomes usable as a fuel oil suitable for diesel engines and domestic heating.

This method of protein production has a number of attractive aspects. The organisms grow rapidly, doubling their weight every two hours, which is probably 100,000 times faster than cow growing on grain or grass. The microorganisms can be grown in tanks; they require no soil or sunlight or rainfall or assistance from human labour and thus the protein production is not effected by had weather or poor crops.

The proteins produced by the fermentation of petroleum differ in no essential respect from those made by any other natural process whether by beef cattle, poultry, fishes, plants or yeasts growing on sugar. They are rich in B vitamins and in a variety of amino acids; in particular, they have a high content of lysine which makes them a useful complement to the lysine-poor cereals. Tike concentrated protein from meat, fish, yeast or soyabeans, "toprina" can be transformed into many different foods, ranging from tasty meat concentrates to fermented fish sauces of strong aroma. It



"Why do I need agriculture and animal husbandry? My entire sheikdam is floating on proteins"

Proteins and their source

THE word protein is of Greek I origin, meaning "first". Proteins are a class of highly complex nitrogenous compounds essential for all metobolic processes. They are present in all living tissues of plants as well as animals. In human body they form 80% of the dry weight of muscles, 70% of skin and 90% of blood. Proteins are of high molecular weight ranging from 20,000 to millions. A protein molecule is composed of hundreds or thousands of amino-acids joined together by peptide linkage. About 20 naturally occurring amino-acids are known (only 8 are essential for human body, others can be synthesised by the body itself) which can compose any protein molecule in a specific arrangement. Properties of a particular protein depend upon the type of arrangement of amino-acids in the molecule. Types of sequence of amino-acid arrangement in a protein molecule are endless and every species may have its own peculiar type of protein molecule. Proteins are colloids when in liquid state. Most of them are soluble either in water or dilute salt solution, e.g., globulins. Fibrous proteins, e.g., myosin, scleroproteins, are insoluble in above sol-They are totally insoluble vents. in fats. A protein may be simple or conjugated. The conjugate proteins possess molecules such as nucleic

acid (nucleoproteins), carbohydrate (mucoproteins or glycoproteins) and fats (lipoproteins). Proteins are first hydrolysed into amino-acids which in turn get converted into body proteins.

Proteins are obtained for human consumption mainly from two sources, viz., animal and vegetable proteins. Former ones are graded better as they contain all the essential aminoacids, whereas vegetable proteins are rated inferior due to absence of many essential amino-acids. Sources of proteins are milk (3.6% proteins); meat (15%-20%); chicken (20%); eggs (17%) and fish (20%). Beef and mutton are the richest sources of animal proteins.

Vegetable proteins are obtained mainly from pulses, i.e., Cajanus cajan (arahar, 13%); Cicer arientinum (Chana, 22.5%); Phaseolus mungo (mung and urd 24%); Phaseolus Sp. (masoor 22%); Phaseolus vulgaris (rajamah, 23%) Arachis hypogea, groundnut (27%) and Glycine max soyabean (43%).

Cereals and some vegetables also contain proteins but low in proportion.

A man's daily requirement of protein varies with age and sex, e.g., children upto 10 years of age require 15-20 gms, adults 45-65 gms, pregnant women 65 gms and lactating women 75 gms.

N.B.

can also be packed as a pure, concentrated protein, like powdered skim milk.

On account of the strangeness of the source, large scale feeding trials for toxicity and nutrition of "toprina" have been carried out. Animals and poultry were tested from birth to maturity—contro! groups being fed on conventional rations with soyabeans and fish meal, while other groups fed only on the experimental protein. Pigs, for example, were

checked periodically for weight, behaviour, general health, reproductive performance and size of litter. The digestive system of a pig is particularly interesting because it closely resembles the human system. The animals were then slaughtered and minutely examined for any signs of abnormalities in the tissues or vital organs specially liver. In poultry its effect was similar to that obtained after feeding conventional rations, while 90% of the pigs showed even than on soyabeans and fish meal Similar tests were made on young calves and in multiple generation of chickens. Both meat and egg were fed to rats. The results showed no detrimental effects.

"Toprina" has been found to be absolutely safe and highly nutritious for farm animals at any stage of life cycle, but much research and cautious human trials are needed before it can be processed and made acceptable to man.

Work in India

In addition to France, Italy, Russia and other countries have built huge commercial plants to produce this new protein. Recently, in India, Indian Institute of Petroleum, Dehra Dun (IIP), under the Council of Scientific and Industrial Research has established, a pilot plant (Fig. 1) for production of protein from petroleum, with a capacity of 50 kg. of protein per day. I.I.P. has direct collaboration with the Institute Fransais Oil Petrole, France.

The IIP has carried out work to study process conditions, reactor performance in relation to design, separation of yeast cream and purification, andcontrol of yeast cell

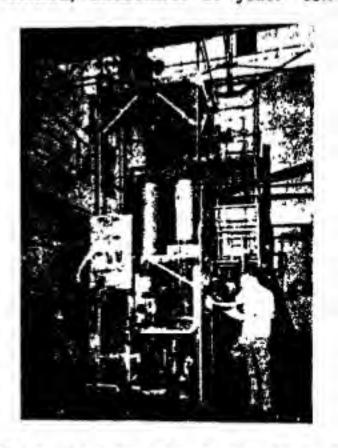


Fig. 1. Pliot-plant for production of protein from petroleum

quality and growth. Long duration continuous fermentation has been conducted with collected yeast from the refinery soil and belonging to the species Candida IIP has tropicolis. completed 14000 hours of continuous operation with the yeast. This yeast can grow well at pH 2.5 to 5.5. and at temperatures 30°C to 38°C. Six kg of protein per hour has been produced with this yeast on hydrocarbons separated from superior kerosene and light diesel fractions having carbon range between 12 to 20. IIP has also developed a method for separation and purification of yeast cream by treatment with a mixture of 2-propanol

and petroleum ether.

After successful trials at III, the pilot plant was shifted to Gujarat Refinery, Baroda in 1969, for scale-up work and later supplemented by a paraffinic hydrocarbons separation pilot unit. The pilot plant at Baroda is being expanded to with better facilities including a spray dryer.

Acceptability tests which include nutritional as well as toxicological studies and large scale feeding trials will be taken up in India as soons a continuous production of consistent quality protein on an adequate scale is established during 1976. Cattle feeding trials should be aimed mainly to increase milk yield.

Further reading

- Neurath, H.M., The Proteins, Academic Press, London, 1963-1966.
- Tanford, C., Physical Chemistry of Macromolecules, John Wiley and Sons, New York, 1963.
- Williams, R.J. and Lansford, E.M., Encyclopdia of Biochemistry, Reinhold, New York, 1967.
- Tracey, M.V., in Kirk-Otmer Encyclopedia of Chemical Technology, Vol. 16, Interscience Publishers, New York, 1968.
- Advances in Protein Chemistry, Academic Press, New York (Annual).

Corrigenda

Ref. S.R. April, 1976, Page 196, the last line in Rajendra Singh's letter should read "...complete absence of linolenic acid."

Page 202, the cartoon legend should read "We have long known that any matter between us women has nothing ultimate in it. How amazing that scientists too have found that there is nothing ultimate in matter"

Page 208, col. 1-2, the equations should read:

$$\begin{array}{ccc} & & & & & & & \\ & & & & & \\ & & & & \\ & & & & \\ & & & & \\ & & & \\ & & & \\ & & & \\ & & & \\ & & & \\ & & & \\$$

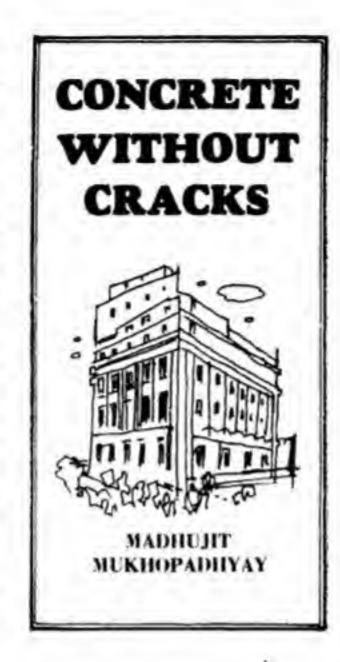
TN spite of its antiquity and general familiarity, the attempt to study the internal structure of concrete is only recent. As regards the behaviour of concrete structures under external loading, the attention is focussed even today on externally observed phenomena, e.g., deflexions, hair-line cracks, etc. The study of internal structure of concrete was first initiated by G. Winter and coworkers in U.S.A. in 1961. The investigations are still continuing and have been undertaken in many universities of other countries. Though the problem is still at the stage of description and classification of observed behaviour, some information has already been obtained on the fracture behaviour of concrete at microscopic level.

Concrete and its manufacture

Concrete is made by mixing four ingredients—cement, sand, coarse aggregate and water. Concrete remains a plastic mass just after mixing and gradually hardens with time. In the hardened state, concrete is thus a heterogeneous mass. The sand and coarse aggregate part, termed as filler, form the bulk of the volume of concrete. Without the filler, the cost of manufacture of concrete would be exorbitant and the dried cement-water mix would shrink.

The most important ingredient of concrete is cement, as it binds the meet filler material into a compact mass. In India, the production of cement is 20 million tons per year. The number of cement factories in the country at present is 53. The sand and coarse aggregate for manufacture of concrete are usually available from local sources.

The different ingredients of concrete are mixed with two basic objectives: first, the mix in the hardened state should achieve a minimum specified strength and, second, in the wet state the mix should be plastic upugh so that it can be handled with the available means without difficulty, from mixing to its final compacted form in the mould.



The behaviour of concrete structures under external loading is focussed even today on externally observed phenomena, for example, deflexions, hair-line cracks, etc.

The advantages of concrete are its high compressive strength, economy, fire-proofing property, capacity to absorb vibration and low maintenance cost. Among the disadvantages are its heavy self weight and low tensile strength. To overcome the drawback of low tensile strength, concrete structures are reinforced with steel rods. It can also be overcome by means of prestressing where stresses are initially introduced opposite in nature to those likely to occur in the structure.

Microcracks

Concrete may get cracked due to various reasons—the load it has to support may be the primary one The internal cracks which occur an referred to as microcracks.

Some of these cracks are very fine and can only be detected by a microscope.

Concrete is also considered as a two-phase material, in which coarse aggregate is dispersed in a matrix of cement-sand mortar. Three types of microcracks have been observed in concrete. Cracks at the interface between aggregate and mortar are referred to as bond cracks; the mortar cracks exist within the mortar, and lastly, there are cracks through the aggregate (Fig. 1).

Indirect investigation of microcracks

The existence of microscopic cracks and its progressive interna splitting under load was first observed by F.E. Brandtzaeg of USA in 1928. When a concrete specimen is compressed axially - compression increases gradually from zero till Volume of the specimen fails. concrete specimens is found to increase at 77 to 85 per cent of the maximum load which the specimen can take (ultimate load), rather than continuing to decrease (Fig. 2). The compressive stress corresponding to this load is known as critical stress. The volume increase signifies Poisson's ratio attaining a value more than half. It is concluded that bulging of the specimen preceding immediate failure is the result of internal tension-microcracking parallel to the direction of applied compressive stress. Instead of measuring volume change, Poisson's ratio may also give microcracking the indication of (Fig. 2).

Among the other indirect techniques of observing existence of microcracks, mention may be made of the sonic method. In the pulse technique, sonic or ultrasonic pulses are sent from one face to the opposite face of the specimen.

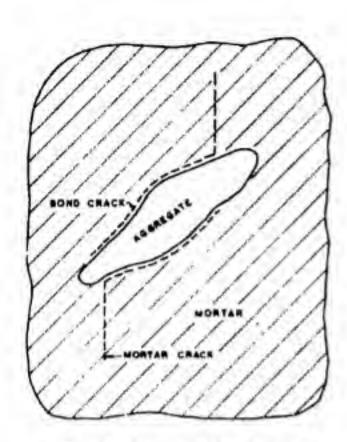


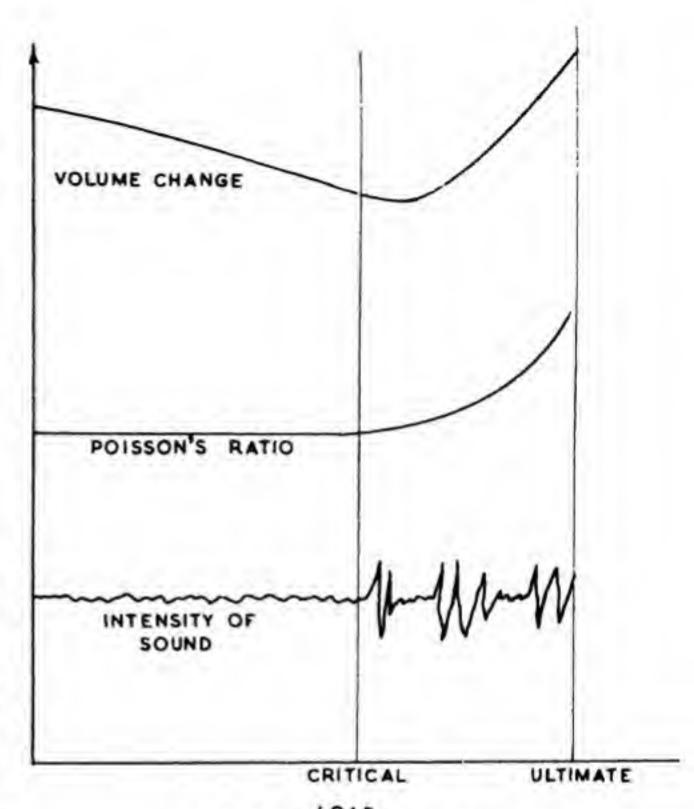
Fig. 1. Microcracks in concrete

Noting the time of travel of the pulse and the distance through which it travels, the pulse velocity can be calculated. If the pulse velocity in the transverse direction is noted at various stages of loading in a uniaxial compression test, the velocity is found to change at 25 to 30 per cent of ultimate load which indicates the formation of microscopic flaws. Such observation can also be made by noting noise in microphone instead of the pulse technique. It is found that cracking noise rapidly increases after a certain stage of loading.

Though there are some other indirect methods, it is only from direct observation that a clear picture emerges about microcracksstrains at which they are formed, their distribution, orientation and propagation through concrete.

Specimen preparation for direct investigation

In the investigations conducted so far, concrete specimens (cylinders of height-diameter ratio of 2) were loaded to an indicated strain and then unloaded. They were then cut to thin slices, 0.4 cm thick, by diamond blade masonry saw in horizontal and vertical directions with parallel



LOAD Indirect study of microcracking

faces. The slices were then washed and dried. They were then painted with red ink and ground lightly to

remove ink from the surface. Cracks and voids were then dyed red while the rest of the surface appeared light

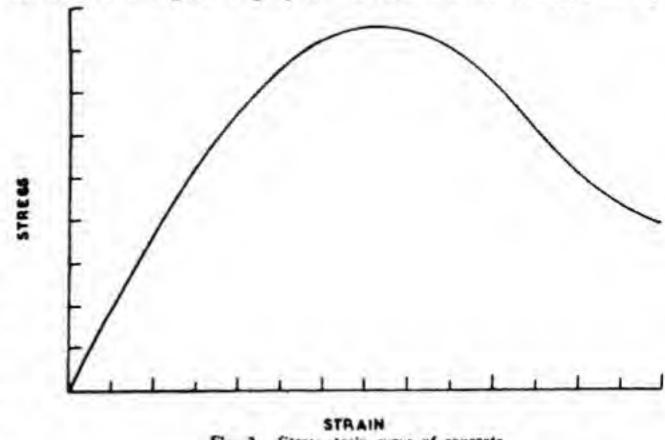


Fig. 3. Stress-strain curve of concrete

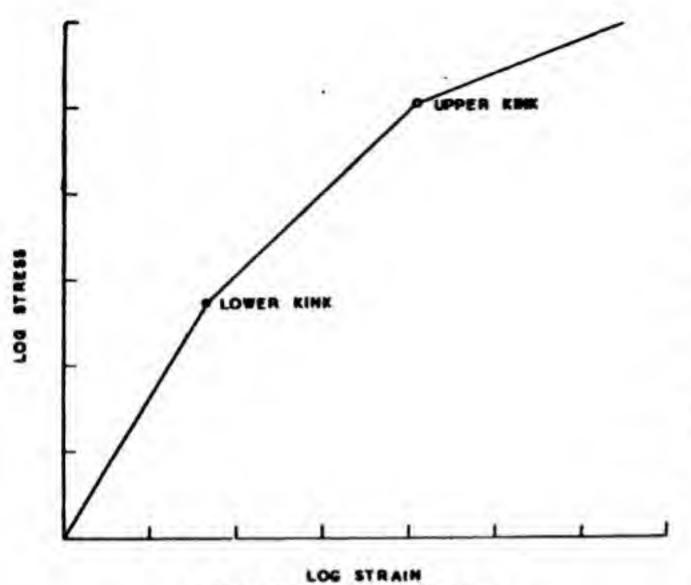


Fig. 4. Log stress-log strain curve

pink. The specimens were then examined with a stereoscopic microscope with 40 times magnification. The specimens were also observed by X-ray technique. The microscope was found to be better suited for observation, but required more time than X-rays.



"My proposal on 'concrete without cracks' has crashed. He says he has found many cracks in it"

Observation of concrete ofices

From the study of the concrete slices of strained specimens, it has been found that bond cracks exist in concrete even before it is subjected to any load. The orientation of these cracks indicates that some of them are caused by segregation of the aggregate from the mortar and others resulting chiefly due to volume changes during hydration. Their presence indicates that the interface, that is the bond, is the weakest link in concrete. Bond cracks generally occur around larger aggregates.

Above approximately 30 per cent of ultimate load, these bond cracks increase in length, width and number with increasing strain.

At 70 to 90 per cent of ultimate load, mortar cracks begin to increase noticeably and form continuous crack patterns by bridging nearby bond cracks. A contribution to the ultimate strength, at this stage, is provided by the mechanical interlocking of coarse aggregate.

A very small amount of cracking is observed through coarse aggregates. Usually the strength of coarse aggregate is higher than hardened paste, though some of the weaker aggregates are indeed penetrated by cracks. The final failure takes place through conspicuous disintegration of the specimen.

Stress-strain curve and microcracking

Any testing in which load is gradually applied from zero till the specimen fails is known as short time testing or "static" testing. A typical stress-strain curve obtained from such testing is shown in Fig. 3. The shape of the curve can be explained with the help of microcracking.

The curve is nearly linear upto about 30 per cent of ultimate load. Beyond this, the curve deviates from linearity in a gradual manner which is due to extension of bond cracks both in length and width. At critical point which is about 70 to 90 per cent

(Continued on page 283)

F the 105 known elements, 83 are metals generally distinguishable by their lustre, malleability, conductivity and ability to form positive ions. Most of these metals occur in small or trace amounts in water, generally in the order of several milligrams or less per liter. Sixty-eight of these metals have a density five times that of water and are classed as heavy metals. Heavy metals include all metals with atomic numbers greater than 23 (i.e., vanadium) except rubidium, strontium, yttrium, caesium, barium and francium. They assume significance because they may be toxic to man and other life forms. Man's activities are increasing their level of occurrence above natural environmental concentrations. The toxicity of a given heavy metal depends on the total amount ingested, as well as on a number of other factors of which only some are known and understood.

A heavy metal may be regarded as toxic if it adversely affects the growth or metabolism of cells when it is present above a given concentration. Almost all, metals are toxic at high concentrations and some are highly poisonous even at very low concentrations. Metals exert their toxicity on cells by interfering with cell metabolism in several ways. The most important one is the effect on enzymesystems. The more strongly electronegative heavy metals (such as copper, mercury and silver) bind with amino, imino and sulfhydryl groups of enzymes, thus blocking enzyme activity. Another mechanism action of some heavy metals (such as gold, cadmium, copper, mercury, lead) is their combination with the cell membranes altering their permeability. Others displace elements that are important, structurally or electrochemically, to cells which thereafter can no longer perform their biological functions.

The toxicity of a heavy metal depends on its route of administra-

Heavy metals include, with some exceptions, all metals with atomic numbers greater than 23. They may be toxic to man and other life forms in higher concentrations



tion and the chemical compound with which it is bound. The combining of a metal with an organic compound may either increase or decrease its toxic effects on cells. For example, the combination of mercury with methyl organic radical makes the element more toxic, whereas the combination of the cupric ion with an organic radical, such as salicylaldoxime, makes the metal less toxic. Generally the combination of a metal with sulfur, forming a sulfide, results in a less toxic compound than the corresponding hydroxide or oxide. This is because the sulfide is less soluble in body fluids than oxides.

However, small amounts of heavy

metals are essential not only for aquatic organisms but for humans as well, to survive and function. The role of iron as a principal component of blood is an example. Also, if a person does not ingest a certain minimum amount of cobalt-containing vitamin B₁₃ he may die from pernicious anemia. Moreover, the minute amounts of manganese, chromium, zinc and copper are vital to man as well as numerous aquatic species.

Drinking water is one of the routes of intake of heavy metals into the human body. Its relative importance, however, varies from metal to metal.

Antimony

This metal is used in alloys and for other metallurgical purposes. There is no evidence that antimony is an essential element in human nutrition; it has, however, been found to be toxic. Doses as low as 100 mg are fatal. The symptoms are similar to those of arsenical poisoning. It has been known to produce severe electrocardiographic abnormalities, skin eruptions and even pneumonia. The compounds of antimony are toxic and are classed as acutely moderate or chronically severe. Since 1949, antimony potassium tartrate been given intravenously in the treatment of schistosomiasis.

Arsenic

Arsenic is used in metallurgy to increase hardening, for heat resistance in glassware and ceramics, in tanneries, dye manufacture and chemical industries. Its major use, however, has been in pesticides for eradication of insects, weeds, and fungi and as a wood preservative. It is also used in the manufacture of arsenical organic compounds for therapy. Normal human blood contains 0.2 to 1.0 mg/l of arsenic. It is found in many foods such as vegetables and fruits.

Arsenic is well-known for its toxicity to humans. Ingestion of as little as 100 mg usually results in severe poisoning and 130 mg has proved fatal. Arsenic accumulates in the body so that over a period of time small doses may become fatal. Arsenical pollution of wells is reported to have caused human deaths in South Africa; in one case the water contained 12 mg/l of arsenic. Several incidents have demonstrated that arsenic in water may be carcinogenic. There have been several instances where cancers of the skin, and possibly of the liver, have been attributed to arsenic in the domestic water supply. In New Zealand, sickness and death among cattle have been caused by arsenic (of natural origin) in water supplies.

Cadmium

Cadmium is used in electroplating, ceramics, pigmentation, photography and nuclear reactors. Cadmium salts are sometimes employed as insecticides and antihelminthics. Cadmium is an accompanying metal with zinc and has also been found in galvanized mains. It may also reach drinking water source, through drain water and river water, and cause poisoning leading to death. The sick die a painful death as a result of the Itai-Itai disease which causes bones to soften and the body to shrink. Considerable quantities of cadmium may accumulate in sewage and river sludge.

Cadmium poisoning in humans results from the consumption of foods or liquids prepared and kept in cadmium-plated containers. As a result, several health departments have forbidden the use of cadmium-plated food containers and pipes. Cadmium-contaminated ice cubes in cold drinks have caused acute gastritis symptoms within an hour. Consumption of cadmium salts causes cramps, nausea, vomiting and diarrhoea.

Chromium

Hexavalent chromium salts are used extensively in metal pickling and plating operations, anodizing aluminium, in the leather industry as a tanning agent, in the manufacture of plants, dyes, explosives, ceramics, paper, and many other substances. Trivalent chromium salts, on the other hand, are used less extensively and are employed as mordants in textile dyeing, in the ceramic and glass industry, and in photography. Chromium compounds may be present in wastes from many of the above mentioned industries and may be discharged in chromiumtreated cooling waters. The toxicity of chromium is not well-known. A case is on record where a family ingested upto 1 ppm (parts per million) over a few years without apparent harmful effects. It is known to be carcinogenic when inhaled, but whether it is so when ingested is not known.

Cobalt

Cobalt and its salts are used for making alloys in nuclear technology, as a pigment in china and glass industry and as binders in tungsten carbide tool industry. It has been reported that cobalt has a relatively low toxicity to man, and that traces of cobalt are essential to nutrition. The ingestion of soluble salts in sufficient concentration, however, produces nausea and vomiting by local irritation.

Соррет

Metallic copper is used in alloys for making cooking utensils, extensively in the electrical industry, and for pipes, roofing and many other purposes due to its conductivity or corrosion resistance. Copper salts in natural surface waters occur only in trace amounts upto about 0.05 mg/1. Their presence beyond this level is generally the result of pollution attributable to the corrosive action of the water on copper and brass tubings, to industrial effluents, or frequently to the use of copper compounds for the control of undesirable plankton organisms. Copper is an essential element for the human body and the adult daily requirement has been estimated at 2.0 mg. Large oral doses, may, however, produce emesis (vomiting) and, if prolonged, may result in liver damage.

Lead

Lead is a cumulative poison. It is deposited in bone as a cumulative poison. Some natural waters wherein mountain limestone and galena are found contain as much as 0.4-0.8 mg/l lead in solution. Lead may also pollute water as a constituent of various

industrial and mining effluents or as a result of the action of water on lead leaden pipes. Typical symptoms of advanced lead poisoning are constipation, loss of appetite, anemia, abdominal pain (and tenderness), gradual paralysis of the muscles, especially of the arms. Lead poisoning usually results from its cumulative toxic effects over a long period, rather than from occasional small doses.

Mercury

Although elemental mercury occurs as a free metal in some parts of the world, it is rather inert chemically and insoluble in water. Hence, it is not likely to occur as a water pollutant. Mercuric salts occur in nature chiefly as sulfide (HgS) known as cinnabar. Numerous synthetic organic and inorganic salts of mercury are used commercially and industrially, e.g., as medicinal products, disinfectants, detonators, pigments and in photoengraving.

Not only is there more mercury in the environment but evidence suggests that more of it is in a form that is most toxic to man. Liquid (metallic) mercury itself is not ordinarily toxic, since the body does not absorb mercury in this form from the digestive tract. However, many intoxications occur when metallic mercury is vaporized and inhaled. mercurials which Organic readily assimilated are also becoming more prevalent. It has been proved that elemental or inorganic mercury. when released into the hydrosphere. is converted into an organic mercurial matter by the linkage of methyl or other carbon chains. Repeated predation by animals in the food chain concentrates organic mercury salts in their tissue ultimately reaching toxic levels for man and animal.

Indirect chronic mercurial poisoning with a much higher morbidity and mortality rate occurred at Minamata

and Niigata in Japan. The poisoning, called Minamata disease, was caused by discharge into Minamata Bay from an acetaldehyde and vinyl factory. The effluent contained large amounts of inorganic and organic mercury. There were 121 recorded cases of human poisoning with 46 deaths. About one-third of the afflicted were infants and children, some of whom had acquired mercury poisoning through the placenta prior to birth. The disease occurred mainly among fishermen and fish-eating families. Fish-eating animals such as cats, dogs, pigs and seabirds were often affected but herbivores such as rabbits, horses and cows were not.

Nickel

The use of nickel in heavy industry has increased markedly over the last few decades, principally in the production of stainless steel and other alloys and in plating. Nickel carbonyl is one of the most toxic nickel coma major industrial pounds and hazard. Nickel is usually not readily absorbed in the gastro-intestinal tract except as nickel carbonyl. This compound has caused most of the acute toxicity of nickel. The toxicity of nickel is believed to be mild Acute poisoning causes headache, dizziness, nausea and vomiting chest pain, tightness of the chest, dry cough with shortness of breath, rapid respiration, cyanosis and extreme weakness.

Selenium

Selenium is used in its elemental form and as several salts in a variety of industrial applications such as pigmentation in paints, dyes and glass production, as a component of rectifiers, semiconductors, photoelectric cells, and other electrical appartus; as a supplement to sulfur in the rubber industry, as a component of alloys, and for insecticide sprays. Proof of human injury by selenium is scanty and definite symptoms of selenium poisoning have not

yet been identified. It is widely believed that selenium is highly toxic to man. It has been observed that the symptoms of selenium poisoning are similar to those of arsenic poisoning Mild chronic selenium poisoning has been observed in people living in areas where the soil and crops are rich in selenium.

Zinc

Occurring abundantly in rocks and ores, zine is readily refined into a stable pure metal and is used extensively for galvanizing, in alloys, for electrical purposes, in printing plates, for dyemanufacture and dyeing processes, and for many other industrial purposes. Zine salts are used in paint pigments, cosmetics, pharmaceuties, dyes, insecticides and other products. Many of its salts are highly soluble in water; hence, it is to be expected that it might occur in many industrial wastes. Zinc has no known adverse physiological effects upon man, except at very high concentrations. An emetic concentration requires 675-2280 mg/1. In fact zinc is an essential and beneficial element in human nutrition. The normal human intake of zinc is estimated at 10-15 mg per day.

The fact is that next to nothing is known about heavy metals in the aquatic environment, besides what little has been learnt from protracted mercury and cadmium poisoning epidemics for example, do living creatures build up tolerances to toxic heavy metals ingested over months and years? Also to be studied is time needed to purge toxic heavy metals from the body, and whether all can indeed be removed. More work is needed to know about precise and biological effects of these metals and their etiology, levels at which signs and symptoms appear with one metal or combination of metals, and importance of genetic effects, if any. The study

Iron transfer to foetus

How iron is transferred from mother to foetus is an interesting story. Earlier it was believed that foetus gets its iron content totally from mother's red blood cells, but now it has been established by isotopic studies that maternal plasma transfers its iron to foetus. It receives a considerable amount of iron from mother's plasma for its total requirement. The transfer of iron goes on increasing with the increase in weight of the foetus. Iron transfer across the placenta is a speedy process and unilateral in direction i.e., from mother's plasma to foetus. Gradually the proportion of iron in mother's plasma decreases, as it is seen that plasma iron of foetus and newborn is higher than the mother's. At the end of pregnancy foetus gets nearly 90% of total iron of maternal plasma. Diminished formation of red blood cells in mother during pregnancy explains the transfer of large proportion of plasma iron to foetus.

On an average the total iron concentration of newborn is about 75 mg/kg of body weight. A full term infant of 3 kg weight has about 273 mg of iron, ranging from 201 to 372 mg of which 10-25 is stored in the liver.

N. B.

Table 1. Permissive and excessive concentrations of fleary metals in mg/l

	Permissive	Excessive	
Arsenic (As)		0.2	
Chromium (Cr he-			
xavalent)	2.5	0.05	
Copper (Cu)	1.0	3.0	
Iron (Fe)	0.3	1.0	
Lead (Pb)		0.1	
Manganese (Mn)	0.1	0.5	
Selenium (Se)		0.05	
Zinc (Zn)	5.0	15.0	

Table 2. Heavy metals in our environment in parts per million

Metal	Animals (dry wl.)	Coel	Plants (dry wt.)	Rock	Sca Water
Cadmium	0.15 - 3.0	0.25	0.1 - 6.4	0.2	0.0001
Chromium	0.02 - 1.3	60.0	0.8 - 4.0	100.0	0.00005
Cobalt	0.3 - 4.0	15.0	0.2 - 5.0	25.0	0.00027
Gold	0.007- 0.03	0.125	0.012	0.004	
Lead	0.3 - 35.0	5.0	1.8 - 50.0	12.5	0.00003
Mercury	0.05 - 1.0		0.02- 0.03	0.08	0.00003
Nickel	0.4 - 26.0	35.0	1.5 - 36.0	75.0	0.0045
Silver	0.006- 5.0	0.1	0.07- 0.25	0.07	0.0003
Thallium	0.2 - 160.0	0.05 -10.0	1.0 - 80.0	0.45	10000.0
Vanadium	0.14 - 2.3	40.0	0.13- 5.0	135.0	0.002

of carcinogenic, genetic and teratogenic effects of heavy metals is also very important.

However, at present the use of different analytical methods and the lack of standardization severely hampers the interpretation of the published data. As these heavy metals may be present in the environment in parts per million (p.p.m.), parts per billion (p.p.b.) or in parts per trillion (p.p.t.) range, in future studies greater emphasis will have to be placed on the analytical accuracy.

Water pollution in India is steadily increasing around industrial and urban centres. Water pollution problem today exists in many parts of the country when almost none existed only a few years ago. Considerable interest is currently being shown in heavy metals concentration in the surface waters and particularly in water sources and waste water effluents. Considering the state of water pollution in different parts of India, water quality standards have been laid down by the Ministry of Health with a view to protect public health and to save fisheries. The Lok Sabha passed on February 21, 1974 the Water (Prevention and Control of Pollution) Act, 1973, which seeks to prevent and control water pollution and maintain wholesomeness of water in the country. Under the Act, industrial and sewage plants will have to adequately treat their effluents before discharging them into rivers, streams and other water sources. The Act also requires boards to be set up for the prevention and control of

water pollution.

Deleterious heavy metals

THE heavy metals are those which possess a density greater than five. Like other metals which are present in a living system in traces, the heavy metals are also found in minute quantities in plants and animals. But heavy metals are more toxic than other metals. Their presence in our body in concentrations beyond a threshold limit produce adverse effects. The metal ions have affinity for a wide variety of ligands which form an integral part of molecules of biological significance. Among them are lipids, amino acids, co-enzymes, enzymes and other proteins. In a living system, atleast following ligands can be expected to be present: -OH, - COOH, -PO,H, -SH, NH, -imidazole. The majority of enzymes possessing -SH group (s) can be inhibited by metals. The result is increase in the substrate concentration and altered physiological activity within the cell. Each metal is toxic to some particular organs. For example, mercury is more toxic to kidneys. Metals like lead, manganese, iron etc., if present in the intestines in excess, form insoluble phosphates and interfere with phosphates absorption.

The limits prescribed by the Ministry of Health, Government of India, for certain heavy metals in drinking water are given in Table 1.

Drinking water supplies in which any of the above mentioned heavy metals is present in excess of the allowed concentration must be rejected as unfit for human consumption. The limits for other heavy metals are not yet prescribed by the Government of India, as the problem has not yet been explored fully. A joint panel meeting between scientists of ICMR and CSIR held recently has decided to undertake studies on heavy metals in water and their health hazards.

Determining heavy metals in water, like most trace analyses, is characteristically difficult. There is no manual of standard procedures available which could be applied to a variety of situations.

Further reading

- Werner Stumm, Equilibrium Concepts in Natural Water Systems, American Chemical Society, Washington, D.C. 1967.
- 2. McKee & Wolf, Water quality Criteria.

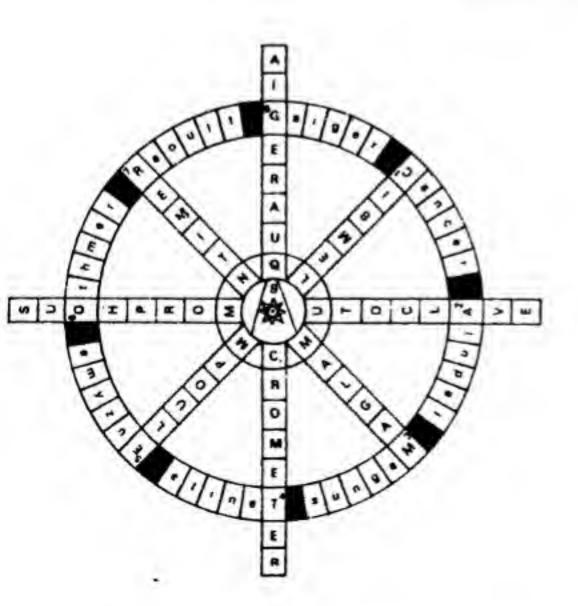
CONCRETE WITHOUT CRACKS (Continued from page 278)

of ultimate load, the curve deviates sharply to the horizontal which results from extensive mortar cracking. A log stress-long strain plot reveals two kinks—the lower one refers to the onset of microcracking

and the upper kink the critical point.

Further reading

- Journal of Engineering Mech. Div., ASCE, Vol. 69 June 1969, pp. 531-543.
- Journal of American Concrete Inst., Vol. 60, February 1963, pp. 209-224.
- Bresler, Boris (Ed.), Reinforced Concrete Engineering, Vol. 1, John Wiley & Sons (1974).





Lightning and thunder understood

L IGHTNING has been an object of curiousity, dread and reverence since times immemorial. The ancient folk-lores explain it as an act of God for punishing the evil. The thunder that accompanies it is understood as the sound of God's whacking whip. Today, this divine act boils down to a trivial scientific phenomenon, the comprehension of which requires only the brasstacks of physics.

The glaring flash, the subsequent flashes; sometimes the accompanying boom; the rumble or roar at other times; or no sound at all—all these happenings can be easily explained in one theory, which has received unanimous recognition only within the last few decades. Nowadays, the basic tenets of this theory are not the issues that researchers debate on; the challenge is how to derive detailed features of lightning from the thunder signatures it provides on the ground.

The lightning discharge

Studies indicate that lightning and thunder have their origin in a charged cloud which is at an altitude of 5 km. The lower part of the cloud is densely negative. and it is the upper part where the positive charge resides. The negative region is disk-shaped, whose diameter is usually 10 km and thickness 2 km. It has been observed to be at -10°C temperature indicating that the development of charge in a cloud is in some manner related to the freezing of droplets and, to some degree, the existence of ice as well. Although the potential difference between the negative charge in the cloud and the ground is enormously high, about 300 millionvolts, it is not enough to bring about a discharge. The spontaneous discharge that is perceived during lightning is, however, not an instantaneous action but a result of chain phenomena that precede it.

The first step directed to achieve a lightning discharge is called stepped leader. The free electrons in the water droplets are accelerated by the prevailing electric fields. They strike the proximate layer of air molecules to disentangle electrons. These, in turn, strike the subsequent air layer to disentangle electrons. Wherever one cascade of electrons loses its energy, the subsequent cascade produced by it takes over, thereby partially ionising the sub-

sequent air layers. In this manner, a partially conducting path for the discharge is produced till the air layer proximate to the ground is conducting reached. The path taken by the charge from the cloud is highly irregular and forms many branches. As the charge reaches close to the ground, the rise in potential difference (i.e., voltage per unit length) between the charge and the ground causes the objects that are much above the ground to spark, As soon as such a spark meets a down-coming charge cascade, a single flash, a surge of current, connects them. It is called the first The time taken return stroke. for the production of this electric channel is 20 millisecond; the return stroke takes few tens of microsecond. This accounts for a lightning discharge. Usually there is not a single flash but 3 or 4 or more, though the first one is the most powerful.

Hitherto only the negative region of the cloud took part in lightning. As the discharges continue, the upper positive region of the cloud joins the fray. The subsequent paths for discharges are created by dart leaders. These form the paths in the same manner as the stepped leader except that they reach the ground quicklier, within tens to hundreds of milliseconds. This is because the path established by the stepped leader is followed by the dart leaders. Once the conductive channel from one region of the cloud to earth has been established, there lies no difficulty for the charge present in other regions to discharge through the same path. Actually, the discharge from one region of a cloud triggers off the neighbouring regions. So, as if in a queue, the discharge from one region of the cloud climbs down the path to be absorbed by earth, to be followed closely by another discharge, and so on.

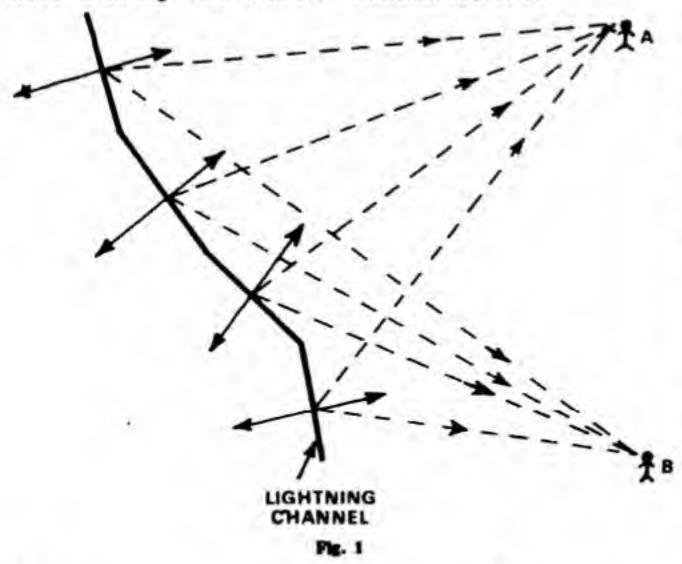
The acoustic signal

The channel for lightning created by the stepped leader or dart leaders is partial ionisation of air. It becomes conductive like a metal wire to a high discharge of electricity. When electricity traverses the channel, it imparts energy to it, which results in heating the channel, while the pressure also rises. Spectroscopic studies reveal that the temperature in the channel rises to 30,000 °C and the pressure exceeds the atmospheric pressure by 10-100 atmospheres. This high temperature and high pressure core of the channel expands as a shock wave. Because of the property of shock wave that it compresses and heats the surrounding air, its velocity is higher than that of an acoustic wave (as the velocity of sound in a medium increases with temperature and compression). As the shock wave expands, the air behind moves outwardly creating low pressure in the channel. The 99 % of its energy the shock wave dissipates to the surrounding air and only 1% to form an acoustic wave. Though the latter part is negligible, it is enough to create the loudest sound made by a natural phenomenon.

After traversing some distance,

the shock wave, having lost its energy, relaxes. This distance is called the relaxation radius (of the circle whose centre is the origin of the shock wave). The relaxation radius depends on energy per unit length of the lightning charge and the ambient pressure. The wavelength of accoustic wave that thereafter takes over also depends on the same factors. The more powerful a lightning stroke, or lower the air pressure, the lower is the wavelength or pitch of the acoustic wave, i.e., the thunder.

It is apparent from above that every lightning is followed by a thunder, then why is it that sometimes a rumble is heard, sometimes a clap, and on rare occasions nothing at all? This depends on two factors-moreover, two factor group of characteristics-where the listener is with respect to the lightning in the first place and in the second the atmospheric conditions about him. For understanding as to how the first group of characteristics affect the sound, the channel of a lightning flash needs elaboration (Scientific American, July 1975).



The lightning channel

A lightning channel is not precisely a ziz-zaz path, it is tortuous straight segments separated by sharp bends. The tortuous elements in a channel are of three kinds:

- (1) Microtortuous element (usually 5 metre in length). As it is usually smaller than the relaxation radius, the shock wave blurs the acoustic wave. In the thunder signature its contribution is difficult to detect.
- (2) Mesotortuous element (usually 5-100 metres in length). These are the primary radiators of the acoustic waves. From the laboratory experiments on sparks, it has been observed that they dissipate, on an average, 80% of their energy confined only to a cone of solid angle 60° whose axis is perpendicular to the spark. A microphone placed end-on to a spark receives much less sound of the crackling it produces than by a microphone placed broadside-on. Exactly the same principle applies to a mesotortuous element.

The mesotortuous elements are generally inclined to each other at an angle of 16°. Consider, then, such a channel of mesotortuous elements (Fig. 1) and two listeners, one broadside-on to it and the other end-on. The maximum amount of energy from the elements dissipates in a solid angle of 60° as aforementioned; this may be assumed to flow along the axis. For the listener A the pulses of sound energy from various elements would reach simultaneously, while for listener B, the pulses would reach in series. In the former case, a powerful thunderclap would be heard and in the latter, a roar of thunder lasting some moments but of a lower pitch.

(3) Macrotortuous element (more than 100 metres in length). Mesotor tuous elements are like pearls strung in a macrotortuous element. Each pearl being a source of acoustic wave

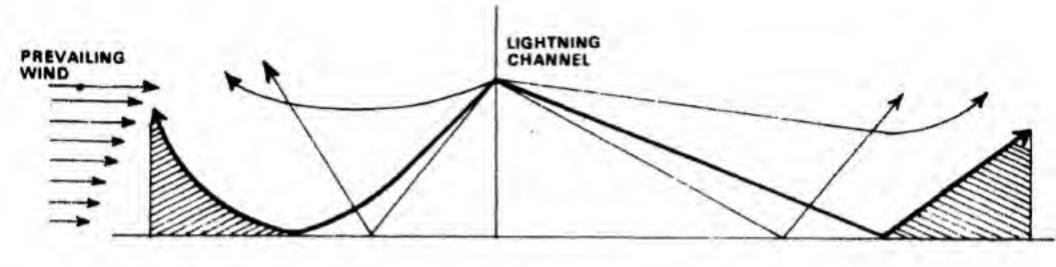


Fig. 2

the spatial arrangement of the element, therefore, determines whether an observer of the lightning flash would hear a thunderclap or a roar, in the same manner as in case of mestortuous elements.

Atmospheric factors

The atmospheric conditions that prevail between the lightning channel and the listener affect the sound in the following manners.

(1) Attenuation. A sound wave is changed by the medium in many respects, viz., its amplitude and waveform. The change is not same for waves of different frequencies and amplitudes. The factors bring in the changes are the viscosity and molecular density of the medium. The former, which is due to the elasticity of the medium, affects a wave in a simple manner, but the atter affects in a complicated manner. Because of the presence of molecules n the atmosphere, the attenuation of sound is a result of the interaction between the acoustic energy and he vibration of water and oxygen nolecules. The attenuation increases with the square of the frequency of he signal. However, by knowing he temperature and humidity along he path travelled by the thunder, he attenuation of a thunder signal an be calculated.

(2) Scattering. This is the result of a highly unpredictable quantity which arises due to the eddies and

These disturbances vary in size from a microscopically small eddy to the size of a thunder storm cell. The maximum amount of scattering is produced by that disturbance whose size is equal to the wavelength of the thunder signal. The scattering is higher for high frequency waves.

Scattering of the wave is also the reason as to why sometimes thunder signals are not audible. In such cases, the low frequency waves, which are less scattered, are absent, and such a thunder can only be heard in close proximity.

(3) Refraction and reflection. The refraction of a sound wave arises due to temperature and wind variation in its path. It is a well-known fact about the atmosphere that with altitude the temperature decreases and the wind velocity increases. As the velocity of sound increases with temperature, the inclination of a downcoming thunder signal is upwardly directed. Moreover, if the direction of the wind is same as that of the thunder signal, it adds to the refraction and, if opposite, subtracts from it (Fig. 2).

When a sound wave gets reflected by the ground its frequency is not changed, except when a part of it is absorbed by the ground. The absorption increases with the increase in the frequency; for a low frequency sound, the absorption is almost zero.

It is apparent from above that a

thunder signal that is heard is either a reflected one or a combination of the direct signal and a reflected one. In the latter case there are chance that the listener may not hear an sound at all or a louder one, depending upon whether the direct an reflected signals add destructively or constructively. A person wit also not hear a thunder signal whe it passes over his head.

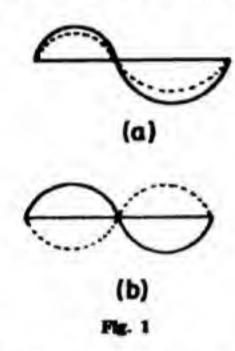
The channel reconstruction

By keeping an array of microphone at various places, then noting th signature of the thunder and the tim it took to reach the microphone, is possible to trace its origin. Thi data in collaboration with th knowledge of the mathematics model of the atmosphere (by knowin atmospheric conditions), th entire lightning channel can b reconstructed with the help of computer. It has been observed that except a few small branches of th channel whose contribution to thun der signal is not apparent, the entir lightning channel can be reconstructed. This method helps in tracin the channel in the clouds when photographic and other optical methods are futile. From this data it is also possible to ascertain th process which enables a cloud to acquire charge, the volume to store it and the time it takes for replenish ment after a discharge.

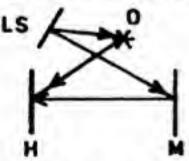
DILIP M. SALW

Holography—photography without camera

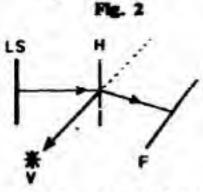
AN you imagine a photograph
obtained without using a camera
r a lens that can be torn into pieces
nd yet each individual piece pre-



erving the original scene in three imensions? All this and much nore is possible by using the highly oherent light produced by laser in novel photographic process called olography. In ordinary photography, light waves reflected from a hree dimensional object are focussed by a lens or a camera on a light-sensitive plate which records the scene as



LS = Laser Source, 0 = Object H = Hologram, M = Mirror



LS=Laser Source,H=Hologram F=Photographic Film,V=Virtual Image

Ple. 3

a two dimensional image. Instead of recording the actual image of the object, holography records the object-reflected light waves. The light waves are recorded by "constructing" an interference pattern of the objectreflected wave-front with a direct wave-front from the same source. The wave-front reconstruction process was discovered by Dennis Gabor in 1947 while working at the Imperial College of Science and Technology, London. The invention of laser in 1960 as a source of coherent light waves has led to the exploitation of the process in a big way.

The basic holographic process consists of illuminating an object with a laser source and positioning a photographic plate so as to receive the reflected light. A mirror is used to beam a portion of the laser light direct to the plate, bypassing the object. The film records the wave pattern of both the direct and the reflected laser beams. An interference pattern so born is called a hologram.

To understand how the objectreflected and direct waves interact, take the simple case of two plane waves derived from the same source and meeting each other at an angle. The plane waves can interact in two different ways (Fig. 1 (a) and (b)). At some places the waves arrive in phase and their amplitudes reinforce each other (mode a). At other places the waves are out of phase and their amplitudes cancel each other (mode b). Modes (a) and (b) are called the constructive and the destructive modes of interaction. They produce a brighter and darker area respectively in comparison to the case where only either of the waves is acting. The waves interfere to produce a uniform fringe pattern (a set of alternate bright and dark areas) the spacing of which depends on the angle between the two waves

A three dimensional object can be regarded as composed of poin objects placed differently in space The amplitudes of waves reflected by various point objects vary. Th places where interfering wave (direct and object-reflected) have greater amplitudes show higher con trast between the bright and th dark fringes. Since the angles o incidence of waves on the recording plate vary, the spacings between th dark and bright fringes also var because the angle between the inter acting waves determines this spacing So all the information about th different points in the three dimen sional object is transferred to th hologram in terms of variations i contrast and spacing of the brigh and dark fringe pattern. Wave reflected from different points on th object carry this information in th form of variation in their amplitude and angles of incidence.

A hologram made in this wa resembles an irregular grating. Just as a number of plane waves ar generated on illuminating a uniforml ruled grating, an irregular wave front is generated on illuminating th hologram with monochromatic co herent light obtained from laser This generated wave-front is a re construction of the original wave front that had formed on reflectio from the object, and has all th properties of the original. By simpl illuminating the hologram with lase light, the original 3D scene can b reproduced as and when desired.

The image seen through the hole gram is called the virtual image, an one feels as if the hologram is window through which the who three dimensional scene is visible. The image has all the qualities of the original scene including the parallal ffects, i.e., if the viewer shifts his position, the relative view of the picture also changes as it would if the lewer were looking at the original cene. If some object is obstructing he other in the scene, the viewer can ave a look at that object by changng his position. Further, unlike rdinary photography, where a point in the photographic plate receives effected light from a single point of he object only, each point on the ologram receives light from all the arts of the object. Therefore, even a mall part of the exposed plate (holoram) contains information from the ntire object, and on illuminaon reproduces the entire scene ith a reduced resolution. Holoraphy has an advantage over the onventional photography in that hologram cannot be immediately ecognised for security and espionage

purposes and nobody would like to pay much attention to an apparently meaningless pattern which may be torn or crumbled, and needs only illumination by a laser light for vital information.

There are many other useful applications of holography including three dimentional TV and motion pictures. Recently, a new form of holography-acoustic holographyhas been developed which uses sound waves instead of light waves to record an original hologram. This hologram can be illuminated with light waves from a laser source to give a three dimensional picture. The main application of acoustic holography is expected to be in surgery and technology because sound waves can penetrate opaque objects like living tissues and metal structures.

B.C. SHARMA

The atmosphere of Titan

With a diameter of 4800 km is ne of the largest satellites in the olar system. We know little about his satellite. It is not easily observible from the earth as the comparably igger sized planets Mercury and far are. Some newly built telescopes are revealed that Titan has an throughout that of Mars and perhaps imilar to that of earth with unknown omposition.

Titan never comes close than 184 million kilometers to the earth out it has its angular diameter less han 0.8 seconds of arc, which is just learly resolvable with moderately arge telescope under excellent seeing onditions.

The study of Titan's atmosphere not new. In the last part of the st decade of 20th century, Spanish stronomer Jose Comas Sola oberved it at Barcelona and pointed out

that the dark limbs of Titan and transient light patches on its tiny disk indicate dense atmosphere. This view was supported by G.P. Kuiper of U.S.A. in the 1940s when he discovered methane absorptions in the spectrum of Titan during a systematic study of the spectra of satellites in the solar system with the new McDonald Observatory 82 inch reflector. In the 1950s multicolour photoelectric photometry of Titan by Kuiper and Haris III showed that the orange colour of Titan is similar to that of lo, the innermost Galilean satellite of Jupiter, and the equatorial belt of Saturn. To find out the origin of the orange tint of Titan, a number of scientists made extensive investigations. They showed that the distinctive wavelength dependence of Titan's reflexivity can be used to detect the nature of the reflecting layer but in the absence of direct spectroscopic evidence the mystery of the origin of orange tint of Tita remains still unsolved. There is som spectroscopic evidence to sugges that the reflecting surface is solid

From studies of the linear polar sation of the reflected light, Veverka of Cornell University and B. Zellner of the University of Arizona reached identical conclusion which are contrary to the idea that the reflecting layer is solid. The dat obtained indicate that the visible light from Titan must be reflected from a opaque layer of clouds, perhapsimilar to the cloud layer on Saturn.

In 1971, L. Trafton of the Univer sity of Texas, tentatively discovere the S(1) line at 8151 A° and in 197 S(O) line of H, at 8272 A" in th spectrum of Titan. This histori discovery led him to proclaim that the atmosphere of Titan must be eigh times more massive than that previo usly thought. At the annual meeting the Division for Planetary Sciences o of the American Astronomical Socie ty held at Hawaii, he reported stron absorptions in the far infrared spectrum of Titan, which means the presence of another gas. Trafton doe not consider this new gas to be methane because individual methan features are not enhanced in Titan' atmosphere.

In 1971, D.P. Cruikshank and D Morrison of the University of Hawaii in collaboration with R.E. Murphy made an entirely different approach to study the atmosphere of Titan They measured the thermal radiation from the satellite in a broad spectra band centred at the infrared wave length of 20 microns. The observed temperature is much lower than expected. This low temperature implies an opaque atmosphere of the satellite. However, the temperature at shorter infrared wavelength is higher. This opacity of the atmos phere at 20 microns is supposed to be caused by molecular hydrogen a high pressure, since methane has no rong absorptions at wavelengths inger than about 7 microns.

C. Sagan and G. Mullen of Cornell niversity calculated the abundance f H_s, which is 10 times more than dicated by Trafton's spectra. This rge abundance of H, is not expected the atmosphere of Titan since an bject of the size of Titan should not ossess such a light atmosphere. o solve the problem, D.M. Hunten f Kitt Peak National Observatory f the U.S.A. has suggested the preence of nitrogen in the atmosphere s a pressurising agent to induce the rong absorptions in the hydrogen and. He further notes that ultraiolet photolysis of Titan's methane nd a probable small amount of ammonia, together with observed hydrogen, could produce a surface layer of hydrocarbons, kerosene and tar, possibly floating on a layer of liquid water. However, at the Hawaii meeting many scientists presented their latest results and discussed their findings without any agreement on the composition or extent of the atmosphere of Titan. But all of them arrived at the same conclusion that the atmosphere of Titan is a remarkable one and is surprisingly large too.

S. KARANJAS

Deptt. of Mathematics

Univ. of W. Bengal

R. BIIATTACHARYA

Darieeling, W.B.

Balanites roxburghii as a source of diosgenin

OSGENIN, a steroidal sapogenin, is the starting material for ne manufacture of hormones which re used for making pills or tablets rescribed for family planning. In ndia diosgenin is obtained mainly rom wild species of Dioscorea, ommonly D. deltoidea and D. praeri, which contain 3.50% .10% diosgenin respectively. These lants are found in the Himalayas. With increase in demand and no seious attempt to cultivate or conerve diosgenin-yielding Dioscorea pecies, the natural resources are lepleting. For family planning programme and for preparation f some other medicines, demand or diosgenin is likely to increase. There is shortage of diosgenin verywhere in the world. btain disogenin researches are being arried on in two directions: (1) o cultivate various diosgenin-yieldng species, and (2) to find out the Iternative sources for the diosgenin or the analogous chemicals from dants, animals or by synthesis.

India, with her vast resources of vegetable wealth and varied climatic zones, can tackle this problem effectively by relying on her plant sources. For this, efforts are being made to cultivate Dioscorea, which has been uneconomic so far. The National Botanic Garden, Lucknow, has developed a method of cultivation of Dioscorea by a tissue culture technique. This technique is said to be economically feasible but even then the problems which are likely to be faced are: (1) development of the tubers takes 3-4 years, and (2) the crop exhausts the soil of its nutrients. It is probable that like some saponin-containing legumes, the roots of Dioscorea secrete some phytotoxins.

The alternative plant sources of diosgenin are:

- (1) Methika (Trigonella foenumgraecum), is a cheap and easily available plant. The Indian commercial samples yield about 0.7% (Puri, et al., comm.).
 - (2) Fruits of various Solanum



species, particularly 5. khasianum contain solasodine which is an analogue of diosgenin.

- (3) Costus speciosus can grow al over the plains of India. Perfume are also derived from this plant as a byproduct.
- (4) Balanites in India are represented by only one species, identifies sometimes as B. roxburghii. Some authors consider it same as the African species B. Aegyptiaca. Recent researches at Kew Garden (England) have shown that the valid name of Indian species is B. roxburghii and is different from the African species. Some botanists place the genus in the family Simarubacea while others in Zygophyllaceae. is a spiny bush or small tree (Fig. found in the arid zones of western

laryana, Delhi, Sikkim, central and outh India.

The plant was well-known in anient India and its seed oil was used
by hermits for illumination. In
a yurveda and folklore medicine, the
lant is known as 'Hingot'. Its
lark, leaves and unripe fruits are
lark, leaves and unripe fruits are
lased as purgative. Seed is used in
espiratory ailment and its oil
applied on burns. A cracker is
lade by digging a hole in the fruit
and then filling it with explosive
mixture.

In a UNESCO study in 1960, it as been said that the plant can be f immense economic importance in rid zones. The fruit is a plumke drupe with a soft edible poron surrounding the single seeded ard and woody stone. The kernel rich in food material. It contains 6%-42% fatty oil and 54%-56% rotein with fairly high lysine content Misra et al., 1975). The kernel conains 0.61% diosgenin. The main roblem in the utilization of the ruit is decortication which has been olved by Hardman and Sofovara (1972) in B. aegyptiaca. The

root of this plant has been subjected to detailed investigation by Puri et al., and the results appear promising. The dry roots less than 0.5 cm thick were found to contain 2.20% steroidal sapogenin with diosgenin to yamogenin ratio of 9:1.

The easy and abundant availability of Balanites and high yield of diosgenin in it shows that at least in India it is a better substitute for Dioscorea. The root of this plant can be easily collected by removing the soil and trimming the side branches to allow the remaining main roots to regenerate in the coming years. Moreover, fruits may also be collected for fatty oil and protein. Diosgenin in fruits would be a byproduct, as is the case with hecogenin in Agave. As the plant is found in backward areas, its collection and utilization on scientific lines has an immense job potential and would provide the nation three essential items: oil, protein and diosgenin.

> H.S. PURI Deptt. of Botany, Punjab Univ. Chandigarh

Male sterility and hybrid seed production

IN many crops the male reproductive parts (stamens) are boorly developed or aborted so hat no viable pollen is produced. This condition is known as male terility. It does not occur as a hance factor but is a definite genetic haracter. Male sterile plants arise only sporadically in populations of oth self and cross-pollinated speies, presumably as a result of nutation. Although such mutations re undoubtedly deleterious in natual populations, they are interesting and useful to plant breeders, because they provide a means of emasculating (removal of male part from a bisexual flower) plants genetically. This simplifies hybrids making in those crops where the cost of hybrid seed production is prohibitive.

Causes of pollen abortion

Dr. S.P. Singh (Botany Department, R.B.S.College, Bichpuri, Agra) and Dr. Henry H. Hadley, while working at the Department of Agronomy, University of Illinois Urbana (U.S.A.) were the first to study the mechanism of pollen abortion

in male sterile sorghum. Morphe logical and cytological studies of the anthers in fertile and steri plants led them to conclude the gene action controls the behav our of tapetal cells (tapetum the innermost layer of anther sporophytic tissue. It supplies nu rition to developing pollen grains which are present inside and i the process it is completely at sorbed and results in degeneration in mature anther). In male steril plants, the tapetal cells remai healthy and persistant and d not supply nutrition to developin pollen grains. Similar studies of pollen abortion were later con ducted by several workers at R.B.S. College, Bichpuri, Agra on severa crop species.

Male sterility can be grouped into two main types: spontaneous (naturally occurring) and induced (artificially produced).

Spentaneous male sterility

The known instances of naturally occurring male sterility can be divided into following three types according to their control method (Fig. 1).

Genetic male sterility. Male sterility depending upon a single general bas been found in many different crop species such as tomatoes, bean and barley. The sterile condition is ordinarily recessive and the male sterile stock is maintained by crossing male sterile plants with heterozygou fertile plants. Half of the progent is sterile and half heterozygou fertile. The main difficulty in hand ling this type of male sterility is that the screening of male sterility is that the screening of male sterility and fertile plants has to be done every year.

Cytoplasmic male sterility. This
type of male sterility depends upo
cytoplasmic factors. Plants carryin
a particular type of cytoplasm ar
male sterile but will produce seed i

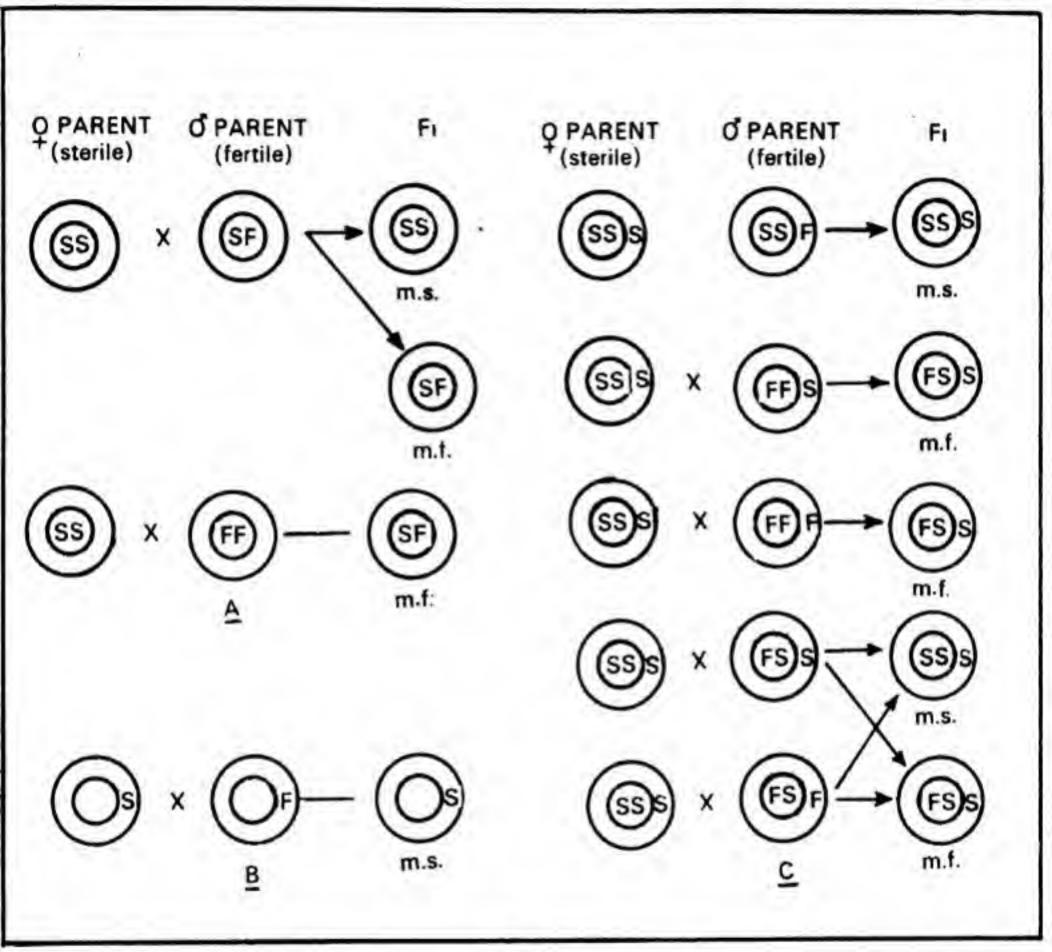


Fig. 1

ollinated with fertile plant. The ybrid seed thus produced will give ise to male sterile plants only, ince their cytoplasm is derived ntirely from the female parent. This type of sterility is easy to handle and has real advantage in those crops there seed production is not desired. Certain ornamental crops, where the esired character is blooming for onger duration, and some commercial crops such as onion, where the inderground bulb is of economic alue, have best use of this type of terility.

Cytoplasmic-genetic male sterility. This type of male sterility is most important and is found in many commercial crops such as wheat, sorghum, bajra, linseed, onion, sugarbeets, rye and cotton. A specific (called sterile) type of cytoplasm in combination with a specific (recessive for fertility) gene causes male sterile plants to develop. When crossed with male fertile plants, the progeny results in fertile, sterile or both types of plants depending upon the genotype of the pollen parents. Those plants which are capable of

restorer' (which restore fertility) and those which do not produce fertile progeny are called 'maintainer (which maintain sterile stock).

Induced male sterility

While studying the effects of plan growth regulators on certain crop plants, H.Y. Mohanram and P.N. Rustogi working at Botany Department of Delhi University first notes that certain chemicals can induce male sterility. This type of mal sterility differs from the spontaneous

ature and remains effective till the ffect of the chemical lasts. Much ork on this type of sterility was arried out at R.B.S. College, Bichuri, Agra but the final conclusion was that this type of sterility is only of academic interest and cannot e utilized commercially.

lybrid seed production

When two unrelated plants (ecopes, varieties, species or genera)
re crossed, the resulting offspring
called hybrid. It is generally oberved that the hybrid progeny shows
nore vigour (called hybrid vigour) in
omparison to its parents. Hybrid
igour can be manifested in a number
f ways; increased yield, greater
esistance to disease and insects, a
horter growing season and better
eed (milling or baking) quality.

To exploit hybrid vigour (heterosis) a commercial crop, and to produce ybrid seed on a large scale, the echnique of hybridization (the proess of producing hybrid by artificial rossing) should be revolutionized. his has been achieved in two major rain crops: corn and sorghum, to lesser extent in bajra also. Other mportant crops are handicapped by heir particular floral characters. For xample, corn, sorghum and bajra re mainly cross-pollinated crops while wheat is 100 per cent selfollinated. In a self-pollinated crop ike wheat, a single hybrid seed can e produced by removing all the stamens of a floret with a forceps nd later dusting pollen from the ther plant on its stigma. Similarly n linseed 5 stamens are removed nd the stigma is pollinated with oreign pollen. To ensure success, all hese operations must be executed vith great care. Obviously, commerial quantities of hybrid seed canot be produced in this manner and nale sterility has to be utilized for

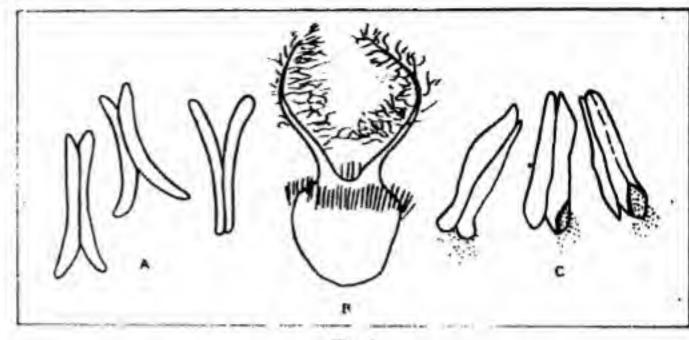


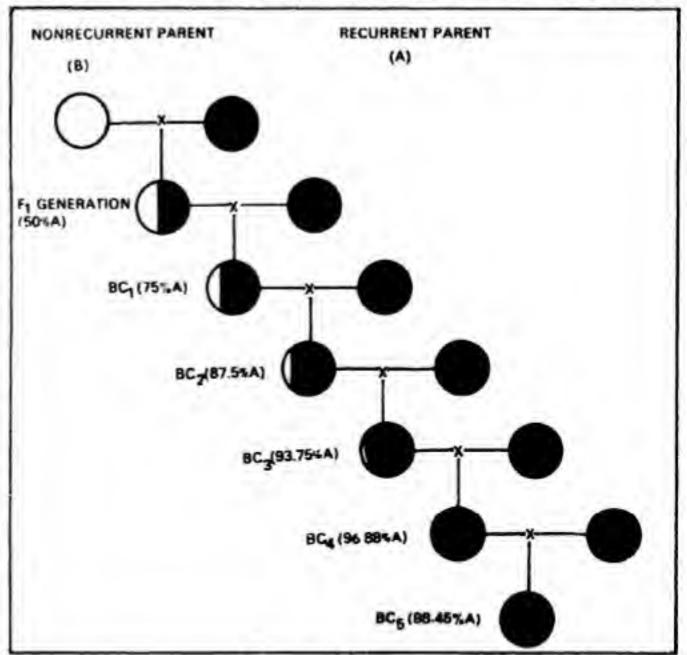
Fig. 2

Hybrid wheat production

Many varieties of wheat already under cultivation are often incorrectly referred to as hybrid wheat. Most modern varieties are 'pure line' selections from the original hybrid cross for six, seven or more years, but they are not true hybrids. Further, hybrid seeds are utilized only in one crop season, and for every other crop season their stock is to be obtained or pro-

duced afresh.

Cytoplasmic genetic type of male sterility has been utilized for hybrid wheat production. The Japanese investigator H. Kihara (Director, National Institute of Genetics, Misima, Japan) first isolated in 1951 the cytoplasmic male sterility in wheat by crossing bread wheat (Triticum aestivum) with a wild relative of wheat called goat grass (Aegilops candata). In 1961, J.A.



Pk. 3

he purpose.

vilson and W.M. Ross working at the Kansas Agricultural Experiment tation (USA) obtained a stable male terile line by crossing Triticum (mopheevi with T. aestivum (variety ison) and called the male sterile ne as 'male sterile Bison'. The Bison ariety was used as maintainer line and the search for good fertility estorer line continued for several ears. At last fertility restorer genes were found in a variety called Primepi' wheat by E. Ohler and M. Ingold of France.

lethod of breeding

When the discovery of fertility estorer gene has been made, all the ecessary requirements for hybrid eed production are present. The male terile line is crossed with the restoer line (A) and in subsequent season he hybrid seed progeny is tested for lybrid vigour. If the combination of nale sterile line and restorer variety A) shows desired vigour in the lybrid, it can be utilized for commerial purposes, otherwise the fertility estoring gene can be transferred to ome other desired variety (B) by packcross method (Fig. 3). As soon as desired fertility restorer variety is obtained, it is utilized as male parent. In the field, hybrid wheat is produced by growing alternating trips of the male sterile and fertility estorer lines. Cross-pollination of the male sterile plant is effected by wind borne pollen from the restorer plant. The seed produced on male sterile line is collected because it is the hybrid seed. In separate fields, male sterile lines are alternated with maintainer line to maintain the male sterile stock for the next season.

Problems of hybrid wheat production

There are several difficulties in producing hybrid seed of wheat which are faced by a plant breeder. The first difficulty comes when the male sterile and fertile lines bloom at diffe-

rent times, with the result that pollination becomes difficult. Another difficulty is that the florets of male sterile line do not widely open and the seed setting is further reduced

The major problem is that of pollen grains. Wheat is strictly a selfpollinated crop and adequate pollen is not found in the field to pollimate all the florets of the male sterile line. In the warmer climate, as in India, the viability of pollen is very little as compared to the cold climate countries. This short span of life poses still great difficulty when strong winds cause further reduction in viability. Too much rainfall or log at the time of anthesis also impedes pollen dispersal. Under these conditions, pollen is washed down or made so soggy that it fails to become air borne.

Future of hybrid wheat

In comparison to corn, sorghum and bajra, the cost of hybrid wheat seed can be acceptable only it of provides greater return per acre of land resulting from hybrid vigour and efficient management. Increased yield is not the only criteria for making it popular but it should also contain good agronomic and quality characters. The agronomic characters like ability to resist diseases, insects, lodging and drought combined with high protein content, good water absorbing and gas retaining properties of the flour, will also result in good quality of fodder.

In the United States and Canada hybrid wheat production programme is in progress and some of the private and federal seed companies are producing hybrid seed. In our country the time is too far when our farmer will sow hybrid wheat in his field.

> SATYINDRA KUMAR Botany Department Agra College, Agra

Microbodies in plants

TYTOPLASMIC particles 0.5# to 1.5# in size have been known to exist in animal tissues for sometime. The term 'microbody' was introduced to describe these particles. These were believed to be ancestral respiratory particles, considered as "fossil organelle." remaining from the time when life originated under anaerobic condition (C. de Duve, and P. Baudhin, 1966, U.S.A.). Their existence in plants has only recently been discovered with the help of electron microscopy. In plants most often the profiles of the microbodies are nearly circular with diameters ranging from about 0.2 to 1.5 (Figs. 1 & 2). Microbodies are widely distributed in higher plants. Among lower plants electron-microphotographs of algae have revealed

such microbodies in Porphyridium Scrippsiella, Chlorella, Euglena Chlamydomonas, Micrasterias, Nitella and Klebsormidium. They also occur in fungi.

Microbodies in animal and plant cells are separated from the general cytoplasm by a single mem brane. They contain an amorphou matrix and, in some cases, a para crystalline core or other types of electron dense inclusions. In anima microbodies, the core contains a of the urase-oxidase activity. Micro bodies differ from mitochondris Microbodies have a single bounding membrane, whereas mitochondri have a double membrane. Ribosoma particles and invagination of th cristae occur in mitochondria bu microbodies do not contain eithe

SCIENCE SPECTRUM.

Aitochondria conserve biochemical nergy as ATP (adenosine triphoshate) whereas microbodies flush it ut. In microbodies phosphorylated orms of substrates have not been ound.

In plant tissues there are at least wo types of microbodies: glyoxyomes and peroxisomes. They are of imilar morphology but differ in enzynic components. Glyoxysomes do ot have any internal infoldings of the nembrane which carry cytochrome ystem. Cilyoxysomes otyledons or endosperm of germinatig fatty seeds contain the β-oxidaon system for fatty acid degradation acetyl CoA (Coenzyme A), and the boxylate cycle for redirecting the arbon flow toward sugar synthesis. In the glyoxylate cycle isocitric rase catalyses the splitting of isocitric end into succinic acid and glyoxylic eid. The succinic acid is then conerted into oxaloacetic acid by the ame reactions as in the citric acid yele, but the glyoxylic acid reacts ith a second molecule of acetyl CoA give malic acid and free CoA.

Peroxisomes from green leaves ontain enzymes of the glycollate athway (given below).

GLYCOLLATE

GLYCXYLATE

GLYCINE

SERINE

3-PHOSPHOGLYCERIC ACID

GLUCOSE

In the glycollate pathway glycolite formed during photosynthesis
converted into glyoxylate and glyine, and that the latter produces
rine with the release of carbon
ioxide. Sugar is formed from serine
a phosphoglyceric acid. The peroxiioxide can convert glycollate to



Fig. 1. Leaf peruxisomes

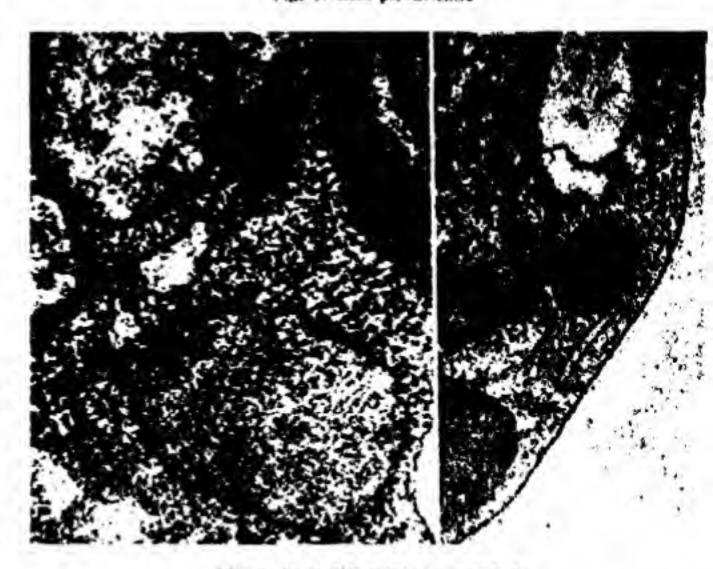


Fig. 2. Algal microbodies, m microbody

lycine but they do not, however, atalyse the formation of serine which s formed elsewhere within the cell.

Because of difficulties in isolation nly limited information is available n enzyme component in relation to utrition of algae. The major diffeence between other plants and uniellular algae lies in the enzymic xidation of glycollate. In leaf peroxiomes, there is glycollate oxidase ctivity which is coupled to oxygen nd hydrogen peroxide production, nd there is much catalase. In uniellular green algae, glycollate is oxiised by a dehydroginase and they lso contain less catalase. Nevertheess, glycollate metabolism in algae ccurs by the same metabolic path s in higher plants but the glycollate athway in algae is not compartnentalised in a microbody. Algal nicrobodies appear to be more analoous to glyoxysomes of higher plants nd may be involved in the metabosm of 2-carbon substrates such as cetate.

MRS. NOMITA SEN

Streptomyces and its impact

organism intermediate in size etween bacteria and fungi. It belongs the family Streptomycetaceae and order Actinomycetales of the class chizomycetes (Bacteria). It is a coil-inhabiting saprophytic microbe which decomposes organic matter. ome of its species like Streptomyces rabies, however, are parasitic and ause disease.

The plant body of Streptomyces onsists of hyphal tubes which have ell walls. They tend to develop

true branches of non-fragmenting vegetative mycelium. Hyphae do not exceed 1.5 μ and are mostly about 1.0 μ in diameter. They are aerobic (require oxygen for respiration) and do not stain with Gram stain. Streptomyces reproduces by exogenously formed, chained round bodies, called conidia. Hyphal nature and mode of reproduction suggest that this microbe is related to fungi but it is closer to bacteria in chemical characteristics and organization of nuclear material.

In laboratory, Streptomyces is cultured on Czapek's solid medium which contains agar, sucrose, sodium nitrate, dipotassium phosphate, magnesium sulphate, potassium chloride, ferrous sulphate and double distilled water. For growth of the most species of this organism (mesophilic species) 25°C-40°C temperature and pH7are ideal. A few species, however, grow best above 50 C on solid medium. The surface of the colony has a powdery appearance like a mould. Species of Streptomyces vary in shape, size, and pigmentation of colonies in culture. For instance, S. griseus is white in colour whereas S. halstedii (producer of the antibiotic carbomycin) is purplish-violet in colour. These characters serve as an aid for the classification of Streptomyces into species.

Antibacterial antibiotics

Credit for better health, longer life and reduced mortality, besides other factors, must also be given to antibiotics, many of which are produced by the species of Streptomyces. Testimony to this is provided by the data of the U.S. National Office of Vital Statistics, according to which mortality in US human population due to tuberculosis bacterium alone was 40.8°, in 1943, which was reduced to 9.5°, in 1955 due to the commercial production of Streptomyces origin) in 1946-47. Some important antibiotics

produced by species of Streptomyco bacitracin. cycloserin include erythromycin, kanamycin, viom cin, actinomycitin, novobiocin, ny tatin, oleandomycin, puromyci neomycin. chloramphenicol an streptomycin. The functional group in these antibiotics include amin sugars, polyene, macrolide, tetracy lic, nucleosides and nitro, etc. Fo example, the amino sugar is th functional group in streptomycin neomycin and kanamycin, wherea polyene in nystatin. In chloramphe nicol, puromycin, tetracycline an erythromycin the functional group are nitro, nucleoside, tetracyclic and macrolide respectively.

The antibiotics have increased the life span of man tremendously. Broat spectrum antibiotic, chlorampenico (or chloromycetin), alone work against pneumonia, carbuncles whooping cough, brucellosis, typhoice enteritis and dysentery. It seems to interfere with protein synthesis and is generally harmless in low doses.

Miscellaneous uses

Rafamycin (obtained from fermen tation cultures of Streptomyces med terranei), amphoterecin (obtaine from S. nodusus) and nystatin (ob tained from S. noursei), etc., are anti fungal antibiotics particularly against skin diseases such as histoplasmosi and coccidiomycosis. Neomycin (ob tained from S. fradiac) is a good disinfectant for skin and clothing Streptomycin (obtained from S griseus) and tetracyclines (from various species of Streptomyces) ar animal growth stimulants (used i silage, etc.) whereas mitomycin-(a metabolite of S. raespitosus), an chloromycetin (obtained from 5 venezuelae) are active against tumour herpes, trachoma and potato virus

As antitumour agents

Streptomyces has a great impact of many aspects of present day cance

research. Its role as a carcinogen is not established. Instead, metabolites of about sixteen species of Streptomyces are known to possess antitumour activity. The metabolites of various species include: adriamycin (S. peucetius), daunomycin (S. pencitins), bleomycin (S. verticullus), tubercidin (S. tubercidicus), neocarcinostatin (S. carzinostaticus), streptozotocin (S. achromogenes), mitomycin-C (S. caespitosus), streptonigrin (S. floceulus), etc.

Streptomyces and space

Space microbiologists employed Streptomyces to find out the effect of space on living organism during earth orbital and lunar exploration missions. In these studies, it was found that Streptomyces culture not only survived but grew enroute to moon and back.

> LOKENDRA STNGH Department of Botany Meerut College, Meerut (U.P.)

Fig. 1

the free energy is not released all once but in gradual steps. If the fre energy were to be released all at one there would be severe cell damag incapacitation or even killing th organism. Unlike an automobile or supersonic jet that can convert her energy directly into work, a livin organism (which operates isothe

Life's energy currency

THE food that we ingest is broken down in the digestive tract into its basic constituentssugars (mono saccharides), amino acids and fatty acids. In the body, sugars are stored mainly in the form of glycogen, amino acids are utilised for tissue protein synthesis and, fatty acids are deposited in the adipose tissues. These substances put together represent the total accumulated energy of the system. The portion of this nergy that can be utilised is called its ree energy. For every activity of the

body-whether it be the movement of limbs or the beating of the heart, maintenance of body temperature.

propulsion of food through the digestive tract, the carriage of messages along the nerves or the contraction of muscles a part of this free energy is utilised. However,

mally) can utilise its free energy i measured amounts, in small denomi nations.

In a biological system the mos important energy currency is th

N-CH3 NH (CH2)3 CH2-COOH H-C-NH2 1,3-diphosphocreatine phosphate glyceric acid COOH arginine phosphate

acetyl phosphate inorganic pyrophosphate

carbamyl phosphate

3 - phosphoadenosine - 5 phosphosulphate

nergy quanta present in the molecule f adenosine triphosphate (ATP). fore than half of the total energy cleased during oxidation of foods in he body is converted into the free nergy of ATP. This molecule is nade up of a molecule of adenine which is 6-amino purine) attached to molecule of ribose to which is ttached a triphosphate chain (Fig. 1). A molecule of ATP releases about even kilo-calories upon hydrolysis ato adenosine diphosphate (ADP) nd inorganic phosphate (P_i). By ydrolysis is meant the breaking up f a phosphate bond by water, with ne water radicals (H) and (OH) ttaching themselves to the open end f the broken bond (Fig. 2). ADP an be further hydrolysed into adenoine monophosphate (AMP) and P₁. ince ATP is capable of releasing ree energy, it is called a "highnergy compound" and since the nergy that is released is due to ydrolysis of phosphate bonds from he triphosphate chain, these bonds re known as "high energy phosphate onds" and are symbolised by the quiggle ~. It needs to be clarified ere that whereas a high energy bond n physical chemistry is one which equires large amounts of thermohemical energy for dissociation, in iochemistry the expression "high nergy phosphate bond" is referred to phosphate bond which, when broken uring biochemical reactions, is capble of releasing free energy. The ydrolysis of ATP is essentially an reversible process. However, biohemical reactions exist that regeneate ATP by conversion of ADP or MP. ATP is also involved in energy ransfer reactions. In fact, the bioogical uses of ATP are far too many be emunerated here.

The ATP molecules in physiological uids are present in the ionised state, hat is to say that one of the valencies of the oxygen atoms in the tri-hosphate chain remains free

making these atoms electronegative (Fig. 1). They are relatively stable to hydrolysis. They are almost omnipresent in physiological fluids and arc akin to mobile energy vaults. Through the operation of specific enzyme systems the vaults are opened to release their free energy to drive essential biochemical reactions. Through the operation of some other specific enzyme systems, the vaults are refilled by the energy derived from the oxidation of sugars, amino acids and fatty acids.

How is it that while the biological esters of phosphoric acid release free energy upon hydrolysis, the hydrolysis of the ordinary phosphate esters needs energy to be supplied? To go into the technical details would be out of place here. It would be enough to state that due to their structural configuration, a certain amount of energy is inherent to all molecules. The inherent energy of a molecule would be more if it is structurally more unstable. A biochemical reaction means a relatively unstable starting material moving toward a more stable state by conversion into its reaction products. From a high energy state the materials move to a lower energy state and consequently to a more stable state. The amount by which the energy decreases is called the free energy decrease of the system and this is the energy that can be utilised to perform some work. Larger the stability of the products greater would be the expectancy of the starting material to get converted into them. As can b seen from Fig. 1, the triphosphat chain of the ATP molecule is rathe unusual in its distribution of electrica charges. The backbone of the chair O-P-O-P-O-P has a succession of partial positive charges. On the out side of the chain are the negativel charged oxygen atoms. Now, because like charges repel, so long as the chair hangs together an internal tensio will exist. When ATP is hydrolyse one of the phosphate bonds break with the release of some of this ter sion and the formation of a mor stable compound, ADP. ADP can b further hydrolysed to give a still more stable compound, viz., AMP. On acc ount of the large difference of ene rgy levels inherent in ATP and AMF the hydrolysis of ATP goes favoura bly in one direction.

The molecular structures of som other "high energy compounds" ar given in Fig. 3. It should not be assumed that all these compound release the same amount of energy Some of them release more freenergy than that released during the hydrolysis of ATP to ADP + P, while many others release much less However this might be, it is the freenergy stored in ATP that make possible functioning of processe involved in the growth, maintenance and function of a living organism.

S.R. CHATTERJE

N.R.L

Indian Agricultural Research Inst. New Delhi-11001

Hydration due to water

UPON initial reckoning, the caption above would seem rather paradoxical. However, if one looks into the nature of regulation of water in the human system one finds that, under certain con-

ditions, the body does approac such a state.

The importance of water in human body cannot be over estimated water forms about 70 per cent be weight of the body. There is as much

as 45 litres of water in an adult weighing about 65 kg. It is found in the extracelluar regions, the intercellular regions and the intercellular regions. It provides the medium within which all the biochemical reactions take place; it also provides the medium for transport of various biological materials present in the body. In this medium are found electrolytes that are of great biological importance, such as the cations Na+, K+, Ca+ and Mg++ and the anions Cl-, HCO-, HPO-4. HPO-4, SO-4, and protein. The chief electrolytes in plasma and extracellular fluids are Na+, CIand HCO, while those of the intracellular fluids are K+, inorganic and organic phosphates, protein, SO-, and HCO-. Under normal conditions an osmotic equilibrium is maintained between the extracellular and intracellular fluids. For the body to function properly, it is absolutely essential that the concentration of the electrolytes throughout the body system be maintained.

The sources of body water are drinking water and beaverages, the water content of the foods ingested. and the water formed during the oxidation of foods. The amount of water required would depend upon the amount of water lost from the body. The average volume of urinary excreion is 1200 ml. This volume dereases with increase in loss of water hrough the skin, lungs, and intestines and vice versa. However, the obligaory requirement of water for the idneys to excrete the average load f waste products per day is about 00 ml. The obligatory loss of vater via the lungs and the intestines

is on the average 400 ml and 200 ml per day, respectively.

The loss of water from the skin, even when there is no visible sweating, averages 4000 ml per day. This loss is obligatory. Any further loss of water due to sweating may vary from zero to as much as 14 litres per day depending on the type of exercise that one performs, and the temperature and humidity of the environment in which it is performed. Along with water in the sweat important electrolytes, Na+, C1- and K+, are also lost. The concentration of these electrolytes varies with the amount of sweat. Under prolonged copious sweating, a high concentration of the electrolytes is lost together with water. This leads to severe dehydration as well as electrolyte deficiencies, especially Na+ and C1- deficiencies. Now, since the plasma and other extracellular fluids have to maintain a certain concentration of these electrolytes, the heavy loss of Na+, in particular, causes further dehydration. Under these conditions, if plenty of water alone is drunk, there is a dilution of the concentration of the plasma and the extracellular fluids in terms of the electrolytes present. To bring about constancy the body gets rid of the extra water, mainly as urine and sweat, causing further loss of the electrolytes with the sweat. This further loss of electrolytes leads to excretion of the excess water, and, therefore, dehydration. Normalcy is re-established by taking both salt and water.

Indian Agricultural Res. Institute New Delhi-110012

S.R. CHATTERJEE N.R.L.

March of the spiny lobster

THE spiny lobster, Panulirus I argus, of the Florida Strait, Gulf of Mexico, and Caribbean Sea as been observed to walk in a single

file formation in long "queues". Each queue may consist of from as few as 15 individuals to chains of a thousand animals extending, with

few breaks in rank, to nearly half kilometre. Moreover, all the anima in a queue move precisely behind the one in front maintaining the san speed and course, like the coache of a train. The purpose behin this can only be conjectured. W know of the amazing migration in animals such as characterist arrowhead-formation of geese homing of salmon t or the their birth-stream. In the sea, dhol crabs (Uca annulipes) move in irregu lar droves on the beach at low tid and hermit crabs gather together i clusters, but no Crustacean is know to move in such precise military for mations as the spiny lobster does.

Why does the spiny lobste start to walk? Since so little known of their habits, probably th apt reply is that given by pro fessional fishermen-because they ge an urge to do so. And this ma not be far from true, as may be see from the persistance of their move ment during field observations an laboratory experiments. A doze spiny lobsters, collected from "queue" and placed in a 44 metr diameter circular plastic pool, imme diately formed a queue and marche continuously around its edge da and night for five weeks, correspon ding to a distance of about 800 km before the experiment was disconti nued! And the urge to walk seem to come simultaneously to most o the lobsters in an area. In five days during the peak of such a march, ter fishermen caught over 20,000 sping lobsters and they estimated that the catch was less than 10 per cent of the animals that were then present in the sea.

What triggers off the urge to move In other animals a variety of reasons are known. The most common reason is that of breeding migration, as in birds. However, this does not appear to be the cause here as juveniles as small as 5 to 8

queues. Seasonal m also form hanges in the length of day (photoeriod) influence the release of horones in many birds leading to migation. Most of the spiny lobster sarches take place during Septemer to November, a season of storms that region. The factor causing he marches seems to be a drop in emperature, rather than shortening f day, as most of the marches take lace after storms which result in ooling of the sea water. To set the ecord straight, however, it may be tated that marches have been obsered during periods of calm also.

A curious behaviour came to light

then some captive animals were kept nder identical conditions but were iven different foods. They were ivided into three groups. The first roup was fed chopped fish, the econd minced clams and hird group was starved. After four ays, the group that was given hopped fish started becoming restas and formed queues; the other wo groups did not manifest this chaviour. After a week of observaon (with the same dietary routine) uring which the fish-fed lobsters ontinued to queue, the diets were ltered. The fish-fed lobsters were iven clams and vice versa. Soon he new fish-fed lobsters (which had arlier been given clams) started ueueing while in the 'clam-fed nimals (earlier fish-fed) queueing ctivity decreased and ultimately isappeared. It could be concluded hat fish contains some substance which induces queueing behaviour. Vhether this works out in the ea remains to be seen because piny lobsters usually feed on slownoving molluscs and crustaceans; hey are just not equipped to catch gile fishes and seldom eat them in ature.

How does a "queue" start? Does spiny lobster use its vision or its ense of touch or smell to initiate

it? A lobster can see another moving individual upto a few metres away. It is noticed to wave its antennae (feelers) towards the other animal and walk towards it. It approaches the animal from behind and touches it with its antennae. Now the more sensitive antennules (first pair of feelers) touch each side of the lobster's abdomen. Sometimes the tips of its walking legs are hooked around the tail of the other lobster. More and more individuals queue up behind, and the tactile locking of the animals enable them to maintain the straight, precise columns. Separated animals persevere to close the gap immediately.

That the sense of touch is the most important has been concluded from the study of blinded spiny lobsters, whose eyes were painted over or taped so as to preclude the use of vision. Once a blinded lobster could effect tactile contact, it would align itself in formation as precisely as a seeing individuals. This indicates that queueing can also be maintained at night or in turbid water. If any one of the receptor appendages (viz. antennae, antennules and walking legs) was broken off or taped, so that it could not perceive a stimulus, the lobster could still queue up with others by using the remaining (unharmed) appendages.

A question, that naturally arises, is: Can any individual form the head of a queue, or is there a leader? If the latter is true, what are the qualities required of it such as experience, aggressiveness or agility? Over 50 leading lobsters were collected and examined to find out if sex or size determined their leadership, but they all turned out to be average indicating that there are no pre-determined individuals which take up as leaders. This was corroborated by field observations. A "pod" closely packed cluster of spiny lobsters was frequently seen milling about in

a group. At some stage an (any individual would move away from the cluster and be followed by the others, initiating a queue. The most actively moving lobsters tended to become leaders. Even when dead spiny lobster or a moult (caseskin), fixed at the end of a pole, was moved about near a pod of inactive lobsters so as to crudely imitate the walking movement of a lobster, the lobsters would become active and start following it.

When spiny lobsters queue, d they take part in an aimed migra tion or just walk in a direction they fancy? Observations hav shown them, in each locality, to b moving in the same direction, i more or less parallel lines. The lobs ters are able to maintain this direction even in turbid water, under a cloud overcast sky, or on sloping bottom of varying substratum. And this i possible even when they are blinded Tagged lobsters, when taken thre kilometres away and released in water 450 m deep, could find their way back to their homes within a week What mechanism is involved in thi uncanny homing ability is anybody' guess. We know that birds and even insects such as bees use the sur as a compass. Even when the sur is not visible dhobi crabs can orien their travels by seeing the sky (thei eyes, unlike ours, are equipped to make use of polarized light).

Finally, what is the use of queue ing to the spiny lobsters? They could as well move in irregular groups. The behaviour is probably of value in reducing losses from predators. The spiny lobster, unlike the true lobster (Homarus vulgaris), has no claws to fight or defend itself against enemies. It relies on its hard armour-like skin studded with spine to ward off any but the hardest jawed fishes (hence the name "spiny lobster"). The most vulnerable part of its anatomy is its abdomen which

s soft underneath. It protects this east-protected portion by tucking it way under a rocky ledge or in a revice, exposing only its front hard ephilothorax to potential enemies. It seems likely, that by queueing he abdomen of an individual is

protected by the cephalothorax of the following lobster; only the last animal in a queue remins at the disadvantage of having its tail unguarded.

> B.F. CHHAPGAR Scientific Officer B.A.R.C. Bombay

Some insects can cure diseases

BOUT one and a half million species of insects are known to name. Many insects are injurious crops, quite a few cause dreading diseases to humans and dometic animals. There are insects then provide us silk, honey and c. Use of insects in medicine limited. Both the insects as well an through ages as medicines.

The bites of katydids or crickets Order Orthoptera) have been reportd to remove warts. The termite ucen, taken as food by some cople, is believed to be a powerful phrodisiac.

The cochineal insects (Family Dactylopidae - Order Homoptera), nown for producing important dyes now replaced by aniline dyes), ave good medicinal properties. The sects contain carmine or carminic cid, coccerin, my restin, fat and atty acids. The insect has sedative, phrodisiae and antiseptic properes, and is used in neuralgia and thooping cough.

Honey, a well-known commercial roduct of honey bees (Family pidae; Order Hymenoptera), is sed as medicine. It is also applied o cure ulcers. The beeswax is used a base for ointments. Bee venom as been used in curing arthritis and neumatism.

The eggs of red ants (Family Foricidae-Order Hymenoptera) have een used by some tribes as a consuent of a medicine for malaria. The most important role of insects is in the use of blow fly larvae (Family Calliphoridae; Order Diptera) in treating decay of tissues. Severe which become infested wounds with these maggots heal better after dressing than the uninfested while wounds. The maggots, feeding on tissues, secrete a substance allantoin which promotes healing process. Allantoin is used in the treatment of osteomyelitis and other deep-seated wounds.

The blister-beetles (Family Meloidae—Order Coleoptera), several of
them are important pests of potatoes,
tomatoes etc., have great medicinal
properties. The blister-beetles are
so named because when a crushed
adult is brought into contact with
human skin, it causes a severe
blister. The blistering agent, known

as cantharidin, is a dangerous dru It was once used as an aphrodisia and is still used to some extent as counter-irritant. When mixed with bay rum, it serves as a hair restore Cantharidin oil, made out of the insects, is very popular. The sul stance is found in blood and in more concentrated form in the re productive organs of the insect It is extracted from the bodies of these insects and is useful in th treatment of diseases of the urino genital system. The blister beetle Diamphidia locusta, is used by Africa tribes to poison their arrows. Th water beetles (Families Dytiscidae an Hydrophilidae: Order Coleoptera are anti-diuretic.

The cocoons of the well-known silk worm moth, Bombyx more (Family Bombycidae; Order Lepi doptera) are used as styptic, tonic and astringent. Their extract is believed to check profuse menstruation, leucorroea and chronic diarrihoea.

MEENA KAPOOI Lecturer in Biology Sacred Heart Convent School Ludhiand

Gars

ARS, garpikes, garfishes or bony J pikes are a group of ancient bony fishes which occur in the freshwater lakes and rivers of the eastern United States of America, Central America, and Cuba. They have long, slender, cylindrical bodies, hard diamond-shaped (ganoid) scales, and beak-like jaws beset with formidable sharp teeth (Fig. 1). The swim bladder of garpikes serves the same purpose as lung of higher vertebrates and enables them to breathe without using their gills. They frequently bask like logs at the surface in quiet waters and give off a bubble of air

filling their swim bladder with fresh air. Due to the double mode of breathing, i.e., by aquatic respiration with gills and terrestrial respiration with swim bladder, garfishes can live



Fig. 1

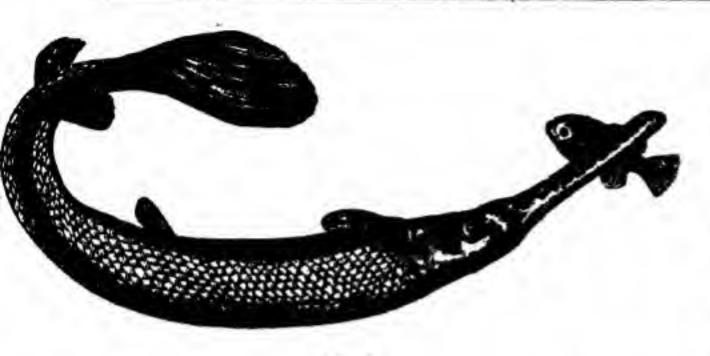


Fig. 2.

ours. They are sluggish fishes, ying motionless on the surface in hallow water—with plenty of aquatic egetation, but can rush upon prey with lightening speed. They re voracious predators primarily reding on other fishes, but the giant elligator gars are known to eat ducks and musk-rats. The prey is effectively pierced and held captive by their ong needle-sharp teeth (Fig. 2).

Garpikes belong to the single genus episosteus (Lepidostrus) and are ncluded under family-Lepisosuborder-Lepidosteoidei; teidae; rder-Semionotoidea; superorderlolsotei; subclass—Actionopterygii, of the class Osteichthyes. These fishes probably arose in the cretaceous period, some 135,000,000 to 63000,000 ears ago. They are older han the rocodile family with which they share nany similarities. The vertebrae of arpikes are decidedly reptilian in ature. Most fishes have vertebrae hat are concave at both ends (amphicelous), but garfishes have ball-andocket joints with the anterior end of ach vertebra being convex and the osterior end being concave (opisthcoelous). Like crocódiles, gars also lash side-ways at food.

The fossils of ancient garfishes have een found in the tertiary deposits in ndia, Africa, North America and turope, indicating that they were nce widely spread and common in

many continents. Fishes with enameled (ganoid) scales abounded in Paleozoic (600,000,000 to 230,000,000 years ago) and Mesozoic (230,000,000 to 63,000,000 years ago) times, but only three kinds such as African bichirs, the sturgeons and the gars persist today as isolated relicts. Because of this long antiquity the garpikes are considered as fossils". Their relatively large, yolkfilled greenish eggs are highly poisonous. This may be one of the reasons for their survival. The gars breed in spring and spawn their eggs in quiet or slow-moving waters. The eggs adhere to object on the bottom of lakes and rivers or to vegetation. On hatching, the larvae attach to nearby objects by means of sucker at the front of their short heads. As the larva grows, the snout becomes longer, and the sucker is lost.

However, garfishes are graduall becoming extinct. One of the principal reasons of this is the cannibalistic embryo-eating habit of the male between 72 to 96 hours of embryo development, depending on the water temperature. The embryo that escape the male, hatch and remain immobile in the birthplace for 72 hours, during which they are exposed to the law of survival. Ferosious cannibalism also occurs betwee the siblings, upto a few days after birth.

There are approximately seven living species of gars, viz., the alligator gar of Mississippii valley Lepison teus (Lepidosteus) spatula, the larges of garfishes attaining a length of about three metres (10 feet) and weighing 45 kilogrammes (100 pounds) the longnose or bill fish, L. osseu with the longest jaws than any garfish the shortnose, L. platostomus; the Florida gar, L. platostomus; the spotted gar, L. productus; the Caima fish or Manjuari of Cuba, L. stractosteus; and L. viridis.

The name gar is also applied to marine needlefishes (Belonidae) in Europe. They look like true gars, but have tiny soft scales instead of harganoid scales.

B.K. BEHUR.

Department of Zoology

Utkal University

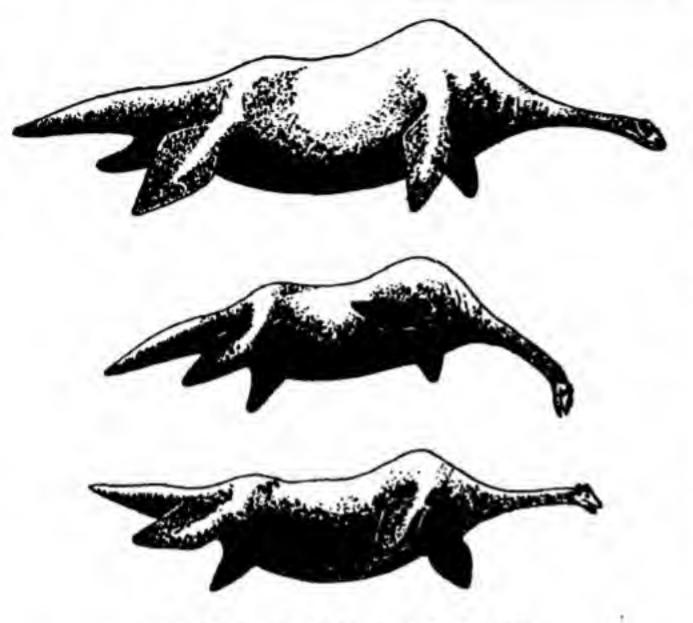
Bhubaneswar 751004 (Orissa

The Loch Ness monster a reality?

A controversy which has been going on since 565 A.D. seems to have come to an end. The Loch Ness monster, whose sighting was first recorded at the time of St. Columba's visit, had been a creature regarded with awe and its description varied with the imagination of the investigating naturalist. The

monster of lake Loch Ness (Scotland has at last been brought to the book and given a zoological name. The December 1975 issue of Nature published a few photograph which give some details of the monster.

The photographs were the result of patience and hard work of Sir Pete



Artist's impression of Nessiteras rhombopieryx

Scott and Robert Rines, who have seen seriously interested in the Loch Vess mystery for quite some years. The creature was photographed at depth of 13.5 m in Loch Ness by stationary time lapse camera with strobe flash, along with a simulaneous sonar trace. The evidence provided in favour of its existence s strong and the zoological name iven to it is Nessiteras rhomboterna (the named species can now be protected under British law). Teras, n Greek means 'marvel' or 'wonder' nostly in connection with monsters, nd Nessi is the pet name by which he monster was designated in the och Ness area. Rhombo indicates diamond shaped' and Pieryx means fin' or 'wing'. The details in the

photographs suggest that Nessiteras rhombopteryx has a body 15-20 m long with a neck 3-4 m. The head may be rather small in proportion to the body and it may have horn-like protuberances. These could probably act as breathing tubes allowing the creature to breathe without breaking surface. animal manoeuvres its body in the water by two pairs of limbs shaped like flattened diamond fins. The paddle is about 2 m long and the back of the animal is like an upturned boat. Zoologists are of the view that Nessiteras may be a reptilian.

What is puzzling biologists is how this pre-historic species has been able to survive till today. It is suggested that between the melting

ice age and the present time, the loch was for a brief period an arm the sea. A population of Nessitera might have got land-locked son 12,000 years ago. The Loch Ne is about 38.5 km long, 2.5 km wide and on an average abou 2100 m deep, the deepest pa being 292.5 m. This might have acted as a closed eco-sphere which was undisturbed by changing env ronments, thus accounting for th survival of the creature. The lake is abundant with fish and weed which Nessi could have used as food It is also expected that there mus be at least 20-30 members in th surviving population of Nessitera. as it is the minimum number required to keep a population viable in nature.

The people who have worked over many years now seem to have presen ted hard core evidence in favou of the existence of the Loch Nes monster. Now efforts must b made to ensure that the species i not tampered with. The public interest generated may result in too many people (scientists or other wise) trying to investigate on their own, which may ultimately result in the extinction of the species. It ha been a common experience that man in his ego for domination has already made many animal species rare i not completely extinct. Who know what delicate balance has kep Nessiteras surviving till today.

B.B. MATHUE Nuclear Research Laboratary Indian Agriculture Research Institute New Delhi-110012



Indo-Soviet Symposium on Embryology of Crop Plants

A N Indo-Soviet Symposium on Embryology of Crop Plants was seld on March 2-6, 1976 under the auspices of the Indian National science Academy and the Centre of dvanced Study in Botany, University of Delhi. This was convened and organised by Profs. H.Y. Mohan and B.M. Johri, Botany Department, Delhi University.

Prof. M.S. Yakovlev (Komarov Botanical Institute, Leningrad), the Russian delegation in his plenary lecture on the origin and development of gametes in Angiospermae highlighted the importance of the study of gametogenesis in understanding the phylogeny of the phylogeny in the source of origin of the phylogenetic branch: Proangiospermae angiospermae.

The process of fertilisation in ngiosperms is known to be the most omplicated process in the whole rganic world. Prof. Helen Gerasimova-Navashina, USSR Academy Science, Moscow, who is one of the pioneers in understanding this rocess described her studies on a

plant, Crepis capillaris. For obtaining viable seeds in incompatible crosses of wheat, the importance of making a time bound study on the disturbances observed in hybrid embryo and endosperm was suggested by Dr T.B. Batygina of the Komarov Botanical Institute, Leningrad.

The embryological observations presented by Indian embryologists have shown that they are at par with their counterparts in the USSR. Prof. B.M. Johri presented his observations on the embryology of Triticale, the first man-made cereal crop. He called for the use of modern techniques like cytochemistry and electron microscopy in solving problems of embryo sac nutrition and related phenomena. The induction of feminization in Cannabis using certain hormones was one of the most interesting observations presented by Prof. H.Y. Mohan Ram. This will help increase the production of 'ganja' because female plants yield more of this hallucinogenic resin. He said that this study could be successfully extended to other economically important plants like nutmeg, mulberry and papaya where the males are unproductive and therefore a nuisance to the farmer.

In his lecture on the enzymes and isoenzymes in dormant and germinating pollen, Prof. C.P. Malik (Punjab Agricultural University) gave an interesting account of the enzyme systems operating inside a pollen grain Dr Dalbir Singh (University of Rajasthan) gave an interesting discourse on the seed coat anatomy. He also pointed out the importance If this study in understanding the various aspects, especially pathological aspects of seed technology. The use of tissue culture techniques is also not unknown to the Indian embryologists. In this field, the most interesting paper was presented by Dr N.S. Rangaswamy (Delhi University), who brought out his informative observations on some vegetable crops and also the cotton plant, using tissue culture techniques.

One of the interesting facts brough out at the Symposium was that a large number of young India scientists are interested in plant embryology. As pointed out be Prof. B.M. Johri in his concluding remarks, this Symposium indicates the necessity of using two modern techniques, cytochemistry and electron microscopy, in solving problem of embryology.

JOSE KALLARACKA

Department of Botan

University of Delhi, Delhi 10000

New atomic particle discovered

T the meeting of the America Physical Society in New Yor in the first week of February, 1976 some nuclear physicists of the Fern National Accelerator Laboratory i Batavia, Illinois, announced the ider tification of a new short-lived atomi particle, heavier than any other identified till then. The evidence pre sented indicated that the particl apparently belongs to the new famil of atomic fragments first discovere in late 1974. The one initially disco vered was named 'J-particle' b some physicists at Brookhave National Laboratory, Upton, Ne York. Those who detected it at th Stanford Linear Accelerator in Pal Alto, California, called it psi. Th entire family is now called psion The new particle is said to have mass more than six times that of proton. The existence of the particl which has a very short life, has bee inferred from its decay product electrons and positrons. The ne particle, which is formed as a resu f bombardment of a beryllium arget by extremely high energy rotons from the most powerful fermi accelerator has been named apsilon' by the investigating team of physicists from Columbia University, New York, Fermi National accelerator Laboratory and the

State University of New York at Stony Brook. The team is headed by Dr. Leon Lederman of Columbia University. Other properties of the particle are yet to be reported.

> R.K. DATTA Beth Israel Medical Center New York, N.Y. 10003

Mercury pesticides banned in U.S.A.

A few years back, in Alamagordo, New Mexico, U.S.A., members f a family became blind and suffeed damage to the nervous system fter eating meat from pigs that had onsumed seeds contaminated with nercury pesticides. Similar cases ere reported from Iran and Japan. iting cases of nervous disorders aused by mercury poisoning from nchecked uses of mercury postiides, the U.S. Environmental Proection Agency (EPA) ordered on ebruary 18, 1976, an immediate ban n the production of virtually all esticides containing mercury. This reventive measure banned the manuacture of all mercurial pesticides sed as bactericides and fungicides paints, varnishes and lacquers and rohibited the use of such pesticides

on turf including golf course areas and in the treatment of seeds. The paint industry accounts for about 90% of the mercury used in pesticides. The EPA estimated that the ban would reduce the mercury now entering the environment by about 98.5%. Most mercury compounds used in pesticides are not dangerous by themselves. However, these relatively innocuous mercury compounds are converted in the environment into toxic methylmercury which accumulates to ever higher levels in the food chain. Consumption or inhalation of enough methyl mercury causes disorders in central nervous system or even death in animals and humans.

R.K. DATTA

C.N.R. Rao elected Fellow of ACS

PROF. C.N.R. Rao of the Chemistry Dept. of Indian Institute of Technology, Kanpur is one of the wentyfive Centennial Foreign Fellows elected by the ad hoc committee of the joint board Council Committee on International Activities of the International Activities of the International Activities of the International Chemical Society (ACS).

Belonging to different nations of the world, all the honorees have to their credit outstanding contributions in the field of chemical science. Thirteen of them are Nobel Prize Winners. Another Asian awarded fellowship in the list is Dr. Seizo Okamura, Kyoto University, Japan.

Dr. Tatum passes away

DR. Edward Lawrie Tatum, th co-winner of the 1958 Nob Prize for Medicine for pioneering work on genetic code and a profe sor of microbiology at New York Rockefeller University since 195 died recently in New York at th age of 65 years. Dr. Tatum, wh helped prove that individual gene the chemical units of heredity, as coded messages specifying the make up of individual proteins, shared th Nobel Prize with Dr. George Well Beadle and Dr. Joshua Lederber for their pioneering genetic studie With Dr. Beadle, Dr. Tatum fire worked with the modern classical too of genetical studies, the fruitfl Drosophila melanogaster. Later, th two scientists used the far speedie genetic system offered by a pin bread fungus called Neurospor Tatum used X-ray crassa. Dr. to produce mutation in this fungu and isolated a mutant strain tha could not grow in the absence of vitamin B. Dr. Tatum postulate that the gene which was affected b X-rays was the one that specified th make-up of the enzyme-protei needed to synthesize vitamin B This work led to the concept of "on gene, one enzyme".

Born on December 14, 1909, in Boulder, Colorado, young Tatur attended the University of Wisconsi at Madison (where his father was head of the department of pharms cology). He graduated in 1930 and received Ph. D. degree in 1934. Hi joined Stanford University in 193 and started work with Neurospore He worked successively at Stanfor University (1937-45), Yale University (1945-48), Stanford University again until 1957 and finally at the Rocke feller University.

R.K. DATT



New diagnostic tests for lead poisoning

L EAD poisoning is an important health hazard and children are specially prone to it. The diagnosis of lead poisoning until recently was a problem. Lead poisoning or lead exposure without clinical symptoms is still extremely difficult to diagnose. Various diagnostic described earlier lack sensitivity. specificity or both. Moreover, when two or more tests are used in diagnosis it is often difficult to decide which one is more reliable. However, in recent years considerable progress has been made in the laboratory diagnosis of lead poisoning.

Two types of laboratory tests currently used in the detection of increased lead absorption are: (1) measurement of tissue, blood and urine lead content, and (2) measurement of metabolic effects of lead on tissues. No single quantitative tissue determination can adequately indicate lead concentration in the body and no single metabolic measurement characterizes all the metabolic effects of the increased lead concentration.

Among the first category of diagnostic tests, the measurement of blood lead concentration is most important. The blood lead test measures the dynamic lead pool of the body and is a reliable indication of exposure to lead. This "accessible" lead pool is distinct from the deposited lead in growing parts of long bones, liver, kidney, etc. Methods to measure lead exposure from the amount of lead in urine are not reliable. Efforts are being made to use lead content in scalp hair as a diagnostic test, because nails and scalp hair levels are already recognised as reliable indicators of arsenic and mercury poisoning. They are even cited in medico-legal cases of poisoning by these elements.

In the second category of tests in which tissue metabolic effects are measured, the inhibition of erythrocytic delta-aminolevulinic acid dehydratase (ALA-D) enzyme activity has been recently suggested as the test of choice because even small amounts of lead inhibit this enzyme to a measureable degree. However, it is now known that the activity of this enzyme is also inhibited by consumption of alcohol, smoking cigarettes, and ionising radiation. Zinc definitely inhibits ALA-D and mercury is suspected of doing so, particularly if large quantities of these metals are present. Measurement of coproporphyrin-III (CP), 8-aminolevulinic acid (ALA), porphobilinogen (PBG), etc., have often been used as diagnostic tests, but they are not absolutely reliable.

The clearest manifestation of the inhibitory effect of lead on the activity of sulphydryl-dependent enzymes is evident from the disturbance it causes in the biosynthesis of heme. The normal pathway of heme synthesis begins with activated succinate produced by the Krebs cycle, a major stage in the conversion of food energy into biological energy, and proceeds through a series of steps Two of these steps (Fig. 1). are inhibited by the presence of lead (solid line); two others may also be inhibited at higher lead concentration (dotted line).

Lead is implicated specifically in the metabolism of ALA to PBC and in the final formation of hemofrom iron and protoporphyrin (PP) Both of these steps are mediated by free sulphydryl-dependent enzymes viz., ALA-D and heme synthetase The other two steps at which lead may possibly be implicated are the formation of ALA and the conversion of CP into PP. These are mediated by the ALA-synthetase and copropor phyrinogen oxidase enzyme. All though the exact mechanism is no

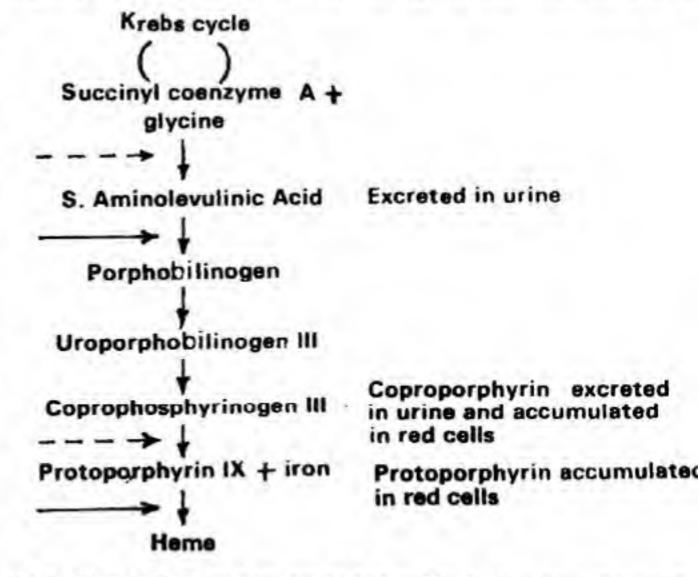


Fig. 1. Biosynthesis of home is inhibited by lead resulting in accumulation of intermediation the synthetic pathway

nown, ALA and CP accumulate n the urine and the red blood cells

luring lead poisoning.

Recently free erythrocyte porphyin (FEP) concentration has been uggested as a reliable test for lead oisoning. Porphyrins are cyclic ompounds formed by the linkage of our pyrrole rings through methyene bridges. A characteristic proerty of the porphyrins is the fornation of complexes with metal ons, which are bound to the nitroen atom of the pyrrole rings, e.g., he iron porphyrins such as heme of aemoglobin and the magnesium conaining porphyrin, chlorophyll, the hotosynthetic pigment of plants.

In nature, the metalloporphyrins re conjugated with proteins to form number of compounds of biologic mportance. These include the aemoglobins, myoglobins, cytohromes, catalases, These etc. measure the ests, 1.C., FEP netabolic effect of increased ead absorption in tissue. Use of from ne test each category rovides not only useful liagnostic profile, but an important

index of response to therapy since their values shall tend to come towards normal values. Both the blood lead level test and the free erythrocyte porphyrin test have been used as screening test. Future screening programme for lead poisoning may well consist of a rapid determination of blood lead concentration by means of the atomic absorption spectrophotometer and free erythrocyte porphyrins by the fluorometric micro method; both of these can now be performed in various research laboratories in our country. This will enable our scientists to assess the incidence of lead exposure in various lead-based mines, smelters and factories as well as in the general population. A suitable screening programme for very small children is, however, wanting because collecting body fluid samples from them is quite difficult.

> T.D. SETH and N.K. SATUA 1.T.R.C, Lucknow S.K. SATIJA Deptt. of Social and Preventive Medicine, M.A.M. College New Delhi



otherwise a completely healthy baby and can be corrected, by earl treatment.

Care of the clubfoot

LUB foot or talipes covers a group of deformities in which he sole of the foot does not face ownwards. In the most common ype of deformity, the foot is twisted nwards and downwards and the atient walks on the upper and outer urface (dorso-lateral) of the foot.

ncidence

Club foot deformity is the commonst congenital abnormality of the oot. The deformity is present at irth. Its incidence is 1 to 2 per ,000 births. It is found in all races. soys are affected more than girls, n the ratio of 3:1. In Lady Haringe Hospital, New Delhi, about

400 cases of club foot children are attended every year. The age group varies from one day after birth to 14 years. In 75% of the cases, correction is obtained by gradual corrective plaster. The rest requires various operative procedures.

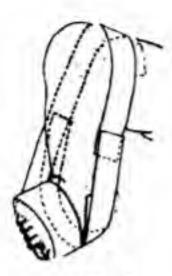
The defect may be due to developmental error of the spinal column, defect in the development of muscles or due to absence of one of the bones of the leg. In some of the cases the deformities are severe and their complete correction is difficult. In majority of the cases the actual cause for the deformity is not known. Such types are called 'Idiopathic club foot'. It usually occurs in

Causes

The causes of club foot have bee the subject of much speculation an many theories have been put forward According to Ruth Wynne-Davie (Edinburgh, Scotland), it is due t mixed genetic and environmenta effect. She found that if one child i a family has the deformity, th chances of second baby having th deformity are 1 in 35 or more. Other regard club foot as of mechanical i origin, caused by abnormal positio of foetus inside the uterus.

It is possible to produce club foo and other defects in animals b injecting drugs like insulin or b depriving the foetus of oxygen. Som surgeons regard this due to abnor





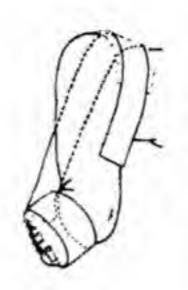


Fig. 2

salities in the muscles and tendons, ut the actual cause is still unknown. The deformity may affect one foot r both the feet. A typical defority is shown in Fig. I. Here the oot is small, heel is turned inside ut, fore-foot is broad and twisted and uter border is curved. Usually there a crease on inner side of the foot. he calf muscles (thick fleshy part f the leg) are wasted. The movenents of the foot are grossly restriced and considerable force is required put it in the correct position. Other ssociated abnormalities may be preent, such as congenital dislocation f the hip, extra-numerary fingers, bsence of part of toes, etc. At birth he bones of the foot may be normal a size and shape, and if not correced may lead to secondary deformities the bones and joints. Bones beome smaller and distorted and later islocated partially or completely. his accounts for the difficulty treating the cases of neglected lub foot.

Changes also occur in the liganents and tendons of the foot.
There is gross thickening and conracture of inner side of the foot and
osterior side of the ankle joint.
The ligaments on the sole of the
oot also get contracted and thickned. In many instances the tibia
is rotated inwards at the longitudinal
axis. In an uncorrected club foot,
the child walks on the outer and
orsal surface of the foot and deveops callosities (thickening of skin)
and bursae (pouch-like formation) on

the outer side of the foot.

Treatment

Fundamentally, treating a club foot is like making a plant or a tree grow in a predetermined direction by holding it in the desired position for some time. Treatment should start as soon as possible after birth. The best time to begin treament is the first day of life. All the deformities should not be corrected at a time. The foot is held in over-correction. Forcible correction should be avoided, for it may cause injury to growing ends of bones, resulting in arrest of growth of

the leg. It should be undertaken by those with special experience of the work. After manipulation, the foot and leg are strapped, especially in the first two or three months. Every week the strapping is changed correcting all elements of deformity by 6th to 10th week. X-ray is used at various stages to know the progress.

After 2 or 3 months of strapping, the foot and leg is put in corrective plaster of paris cast. Plasters are changed every two weeks. The plaster is continued till the foot evert and dorsiflex beyond the neutral position. This is likely to occur within 9-12 months from birth Once the child starts walking, a special below-knee caliper is fitted for a period of 5 years. Seventy-five per cent feet are usually amenable to corrective plaster. The rest 25% need surgical correction.

Assit. Prof, Orthopaedic Surgery
RANBIR SINGE

Registrar, Orthopaedic Surgery Lady Hardinge Hospital, N. Delh

Malnutrition—the cause of aggression

DERSONS with aggressive beha-I viour are a menace to our society. Ethical reasons, however, prohibit scientists to conduct directly research on aggressive human subjects to find out the causes of aggressiveness in them. Consequently, animals are a good means to explore the causes of aggression, provided the results so obtained could be extrapolated to human beings. Dr. Edward S. Halas and colleagues of the University of North Dakota, have recently (Nature, Vol. 257, p. 221, September 18, 1975) reported their studies on aggression in adult rats whose mothers were either given zinc deficient diet or were kept under-nourished. Zinc is an important metal required for the normal development of the brain.

Earlier studies on the effects o zinc deficiency at prenatal stage, have shown that the size of brain in foeta and neonatal rats is reduced and tha the synthesis of genetic materia (DNA) in brain is impaired. Also severe zinc deficiency (during preg nancy) in rats leads to brain mal formation in rat foetuses. Based or reasons, zinc deficiency in prenatal development was studied fo its possible relationship to aggres sion. The studies suggest that under nourishment in general and zin deficient diet in particular lead to aggression in rats. More research is, however, needed to find out i these results arc applicable to human aggressive behaviour as wel

ZAKA IMA



Mathematical talent search in U.S.A. and India

T is a common knowledge that the aptitude for mathematics for that matter any other subject) hows up at an early age. A favouable environment may mould a recocious child with a flair for nathematics into a creative mathenatician. The mathematics educaion that a child receives in its early lays at the school has a decisive nfluence on its developing a like or lislike in the subject in later years. competitive test on mathematics t the school-leaving stage is a useful uide to identify those students who ave developed and nurtured a lively nterest and admiration for mathenatics from their formative years. his article recounts in brief some f the highlights of the mathematics alent search competitions which re being conducted in India and he U.S.A. for the high school and ollege students.

fathematics talent search in U.S.A.

In the article, Second U.S.A. Matematical Olympiad, (The American fathematical Monthly, 81,3,74) the uthor S. Greitzer writes on a new enture to spot secondary school tudents with superior mathematical alent—those, who possess creativity, eventiveness and computational kills. The first Olympiad was held a 1972. Participation is restricted to

about 100 students "selected mainly from the Honour Roll of the Annual High School Mathematics Examination, plus a few recommended students from those States which sponsor their own High School Mathematics Competitions". The Olympiad consists of five essay-type problems. The author has not mentioned the time allotted for solving them. The examination is conducted by an Olympiad Committee which is supported by scientific bodies like Mathematical Association of America, etc. The Olympiad Committee (1974) consists of six belonging presumably to mathematics faculties of different American Universities or Colleges. There is a separate committee to grade the papers. Two questions from the Second Olympiad (1973) are reproduced below:

- Q. 1. Two points, P and Q, lie in the interior of a regular tetrahedron ABCD. Prove that angle PAQ <60°.
- Q. 4. Determine all the roots, real or complex, of the system of simultaneous equations

$$x+y+z=3$$

 $x^{2}+y^{3}+z^{3}=3$
 $x^{3}+y^{3}+z^{5}=3$

Other three questions and further details about the Second U.S.A. Mathematical Olympiad can be obtained from Greitzer's article, partial summary of which has bee given above. The author mention that the solutions to the problem will apper in a forthcoming issue of Mathematics Teacher.

The second interesting article The Stanford Competitive Examination Mathematics (The American Mat. Monthly, 80,6,73) G. Polya and Kilpatrick describes in considerab detail the mathematics talent search examination (initiated by Prof. C Szego) used to be conducted by the Stanford University for high school seniors. According to the author "the immediate and principal purpos of the examination was to identify among each year's high school graduates, singularly capable stu dents and attract them to Stanford The broader purpose was to stime late interest in mathematics amon high school students and teacher as well as the public". The exam nation was conducted for twent years starting from 1946. It has been discontinued from 1966, mainl Mathematic Stanford because Department shifted its interest t graduate training.

The aim of the questions set is the examinations is to test for originality, insight and a high degree of ingenuity of the participants. Cred is given to clear, concise and complete presentation. The candidate are given three to five problems to be attempted in three hours. Here is a complete sample of questions.

- is the square of an integer.
- The three sides of a triangle are of lengths l, m and n respectively. The numbers l, m and n are positive integers,

 $1 \le m \le n$.

- (A) take n=9 and find th number of different triangles of th described kind.
- (B) take various values of n and find a general law.
- 3. (A) Prove the following theorem: A point lies inside a

quilateral triangle and has the istances x, y and z from the three ides respectively, h is the altitude of the triangle. Then x + y + z = h.

(B) State precisely and prove the nalogous theorem in solid geometry oncerning the distances of an inner oint from the four faces of a regular etrahedron.

(C) Generalize both theorems that they should apply to any oint in the plane space, respectively and not only to points inside the riangle or tetrahedron). Give presse statements and, if you have time, lso proofs.

The method of search for mathenatics talent among school boys in ne U.S.A. may be a novel one but it not a new one. Polya mentions f similar tests (Eötvős Competition) rganized in Hungary in 1894. The ompetition was named after Baron on Ronald Eötvös (1848-1919), distinguished Hungarian physicist nd experimenter in earth's magnesm and gravity. The competition 1 Hungary perhaps drew inspiraon from similar tests in England nd France. The renowned German nathematician and inspiring teacher elix Klein (1849—1925) introduced the early nineteen hundred new forms in mathematics instructions the gymnasiums. One of his leas was to show the mutual connecons between arithmetic, algebra, nalysis and geometry through cusy xamples occurring in the school urriculum. The relevance of this eference to Klein will be appreciaed if we remember that a talent earch test in mathematics is meaningul only when the school course nd instruction in mathematic are p-to-date and attractive.

The article by Polya and Kaparick contains the complete set of roblems from the Stanford University competitive examination in mathematics and a valuable list of eferences besides discussing the

source and purpose of the problems set. The authors refer to a booklet, The Stanford Mathematics Problem Book, which contains the problems and a complete set of hints and solutions. The article is an indispensable contribution to similar mathematics talent search examination programs.

Efforts in India

Quite a few academic institutions in India are conducting mathematics talent search examinations annually. name 'Mathematical Under the Olympiad', a mathematics talent search competition for the students of high schools and junior colleges is held annually by the Andhra Pradesh Association of Mathematics Teachers (APAMT). Their Olympiad was conducted in 1974. A similar body (DAMPT) in Delhi has been holding Mathematics Olymplad Test since 1971. It is open to mathematics students of X and XI Classes. The Association of Mathematics Teachers of India, Madras, started their Annual Talent Competition in Mathematics in 1970 at three levels school level; X and XI standards; and college levels (Junior and Senior). The Association for Improvement of Mathematics Teaching (AIMT). West Bengal, has already conducted two mathematics talent search tests (1974 and 1975) for high school finalists. There are also proposals to hold an Indian Mathemitical Olympiad so as to enabl: India participate in the International Mathematical Olympiad started in 1959 by the east European countries.

At the talent search tests held by some of the institutions mentioned

above about twenty to thirty questions on an average were set and the students were asked to attempt as many questions as they could in three hours. The problems were mostly from topics covered in high school syllabus; e.g., algebra, geometry, elementary number theory and A few questions trigonometry. were of the 'objective type', i.e., a number of possible solutions were given and the candidate was to pick out the correct one. Again there were problems where the candidate had to infer the correct solution from a given pattern or conversely conjecture the general pattern from a few given special instances. There were also questions based on geometrica constructions, symmetry of geometrical figures and coordinate geometry

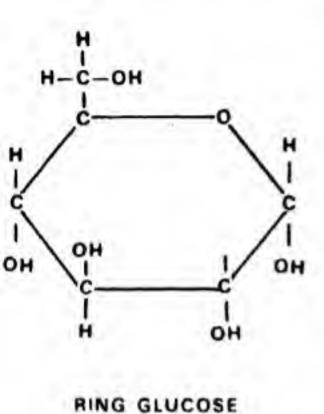
The motive behind setting a large number of questions is to test the quickness of thinking on the part of the participants. Correct answers to a large number of questions testify to the quick and intelligent guess work of a student. But a talent search paper should also try to probe deep into the thinking of a student not his guessing power alone. This can, perhaps, be achieved by asking the students to answer at least some questions in detail (e.g., see the Stan ford Univ. Q. 3, 1949). Then should also be a few questions or concepts which are quite unfamilia to the student to see how he think in a completely alien environment This implies that the best studen should be required to show hi research ability as well.

SHYAMAL K. MAJUMDAN Computer Centre Jadavpur University, Calcutta-70003

Molecules that make life possible

THE smallest form capable of carrying on life processes independently is the living cell. It

fats or lipids 2%, nucleic acids 3% and carbohydrate 1%. These cor



titute four groups of biomolecules which are made up of atoms—H,

-O-, -N-, -C- and
-P- (HONCP), and the groups avolved are -OH, -C- OH,
-COOH, -NH, O

The smaller biomolecules formed by HONCP atoms are sugar, amino cids, fatty acids, steroids, and sucleotides. Big biomolecules are ust chains of small molecules which are specific shapes and specific unctions.

The energy by required cell comes rom food. Green plants convert olar energy into food energy, and oth green plants and animals convert food energy into ATP. The ATP, o formed, is spent for repair, growth, notion, reproduction and many ther life activities. ATP supplies nergy by donating a phosphate group to other molecules and leaving behind ADP or molecules that can be econverted into ATP by addition of phosphate group. This phosphate group comes from food.

We will now describe how a change in the position of atoms in these biomolecules changes their molecular function altogether.

Carbohydrates

Galactose and glucose have the same molecular formula C₆H₁₈O₆. The small difference in atomic arrangement gives the following structures:

Glucose is the most common food sugar, whereas galactose is present in milk which the babies use. It has been found that some babies suffer from tissue injury called galactosemia. This is due to incapablity of some children in converting galactose into glucose. The ring form of glucose is called glucopyranose or ring-glucose which has the property of forming long chain structures called polymers. The polymers of ring glucose are (i) cellulose, and (ii) starch. Hundreds of ring glucose molecules combine together to form these polymers; cellulose has chains interlocked together to give tough fibres of wood and cloth. When the latter is coiled and forms granules, they serve as storage of A little difference in energy. the arrangement of ring glucose results in a large number of compounds.

Protein

Proteins are responsible for many of the substances and most of the functions of the living cells. Protein make hair and the blood clo carry oxygen with blood, stimular growth, derive energy for muscular movement, build bones, etc. Like carbohydrates, the functions of different proteins depend upon the molecular structure, i.e., change if the structure of a protein alters it role in the life processes. Thousand of chemical reactions occurring simulatineously and persistently in metabolism are activated by protein called enzymes.

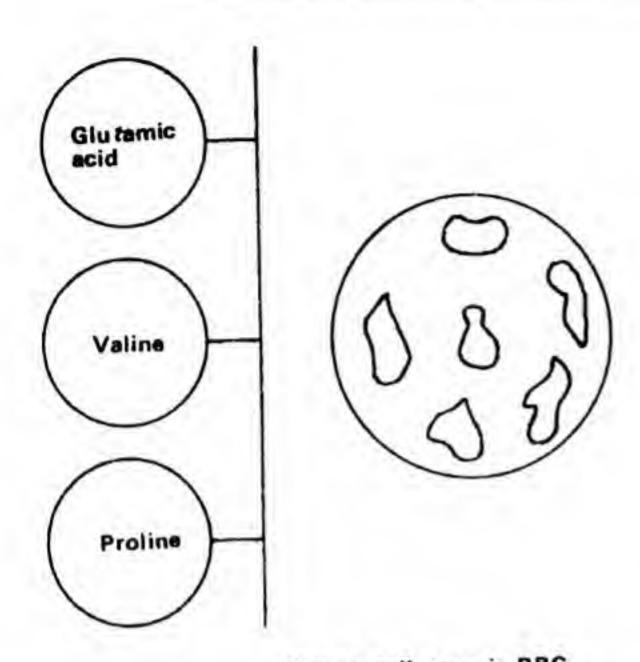
Proteins are polymers of amine acids. Misarrangement of amine acids is a major cause of hereditary diseases. Proteins exist in two forms (1) fibrous—like a straight chain and (2) globular—like chains tied into tight knots. Since they are folded in particular ways, proteins are liable to three kinds of actions (1) denaturation—a loss or change of normal function, (2) binding—the ability to hold smaller molecules and (3) complexing—fitting togethe with other large molecules.

There are many vitamins which act as parts or cofactors of enzymes. The enzymes can be reused and are required in small amounts for repetition of innumerable daily chemical reactions. The vitamins so used are given in Table 1.

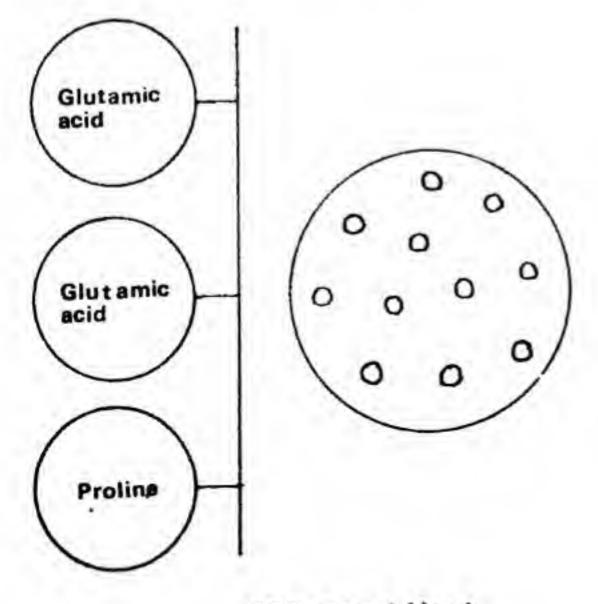
A sequential arrangement of about twenty amino acids is required to produce any of the proteins. Haemoglobin has the amino acid sequence of proline—glutamic acid—glutamic acid. If this order changes to proline—valine—glutamic acid, the person with this type of haemoglobin suffers from a disease known as sickle cell anemia. This disease

Table 1

Vitamin	Coenzyme	Enzyme
Nicotinamide	NAD	Dehydrogenases
Riboflavin	FAD	cytochromes
Polic acid	Coenzyme F	transferases



Sickle cell anemia RBC



RBC-normal blood

arises as a result of faulty hacmoglobin-producing faulty red blood corpuscles, and kills thousands of people every year.

Nucleic acids (DNA & RNA)

Of all the biomolecules, nucleic acids excel in glamour and have attracted most of the scientific thinking in the world in the recent past DNA opens the door to the bright possibilities of curing cancer, keeping away old-age manufacturing spate organs, abolishing hereditary defects making memory pills and achieving numerous other miracles in the field of genetic engineering. DNA supplies and stores information about making more DNA and proteins DNA are polymers of nucleotides. Lack nucleotide has three parts: sugar phosphate and base The sugar and phosphate join end-to-end to make the DNA "backbone", while the bases attached to the sugar stick out from the polymer chain. DNA includes two nucleotide polymer joined together (double strings) by matching the complementary shape of their bases. In the four base there is specific pairing of G with G and A with I.

RNA differs from DNA in two ways. RNA contains uracil ins tead of thymine and in DNA ther is no oxygen atom (deoxy meanin without oxygen) at position 2 of th ribose structure Because of thes two minor variations we find tha DNA and RNA differ widely i their biological functions DN/ carries the genetic informatio whereas RNA synthesizes the pro teins only. To reproduce DNA, th double helix unrippers bases int single chains and then rezippers b interlocking the bases of free nuclea tides.

The living egg cell, which is the origin of a human life, is devoid or blood and blood-oxygen carriers such as haemoglobin. During develop

nent, the DNA of the blood-forming ells uncoils and matches amino cids with DNA bases to form haenoglobin.

Radiations (atomic, cosmic, or Itraviolet) can cause changes in NA (called mutations) giving rise changes in genetic properties. If the doctors are able to change hat particular base in DNA which is esponsible for the formation of ickle cell haemoglobin, we might proot one of those deadly diseases hat have claimed lives heavily. The elationship between DNA, protein and hereditary trait is expressed as:

DNA → Protein → Trait

Ve can hope to use the knowledge
bout DNA not only in correcng hereditary defects but also in
roducing life forms with preplanned
haracteristics some day.

ipids

The fats or lipids are nonetheless

important. Even the neutral fats serve as vital electrical insulation around nerves, electrical and frictional insulation around the heart, and heat insulation under the skin. Phospholipids combine with proteins to form the membranes largely responsible for organizing all other biomolecules into coordinated living units called cells. Formation of fat depots is one of the vital functions of biomolecules in the lipid group.

Polyunsaturates, the neutral fats, devoid of required hydrogen for saturation, seem to lower blood cholestrol which has been associated with hardening of arteries. Recommended health diets often include polyunsaturates, but relatively little cholestrol.

V.K. SRIVASTAVA B.P. GAUR Deptt. of Chemistry University of Gorakhpur that temperature is measured with reference to the amount it can hold at 100%. It is called relative humidity of the air at that temperature. For human comfort, relative humidity in the range 35%-70% at 25°C in summer and 20°C in winter is required.

Suppose there is more of moisture than the air at the prevailing temperature can absorb, then, it is obvious, that all the moisture would not be absorbed by the air. The excess moisture would coalesce and condense to form droplets. To prevent this there is only on solution: the temperature may be raised so that the hotter air hold more of moisture allowing no condensation.

Human body, too, is a moisture producing system. Small pores all over the body ooze out moisture a sweat. It is produced at a high rate in summer and at a low rate in winter.

In summer, a room is kept shu to prevent hot airs from comin in. As the inside air is at a lov temperature, the moisture it can hole is relatively low. When our bodie ooze out moisture, it is not absorbe by the already saturated air. I condenses on our bodies to produc perspiration. This usually happen when a man enters a room cooled b a "grass-mat". In winter, room i kept shut and heated, say, by a room heater. The temperature of the ai would be high and it would be almost dry because our bodies ooze ou little moisture. Such a condition affects our bodies adversely: th membranes of nose and throat ar affected causing irritation and dis comfort. All this, therefore, neces sitates the proper control of tem perature and humidity.

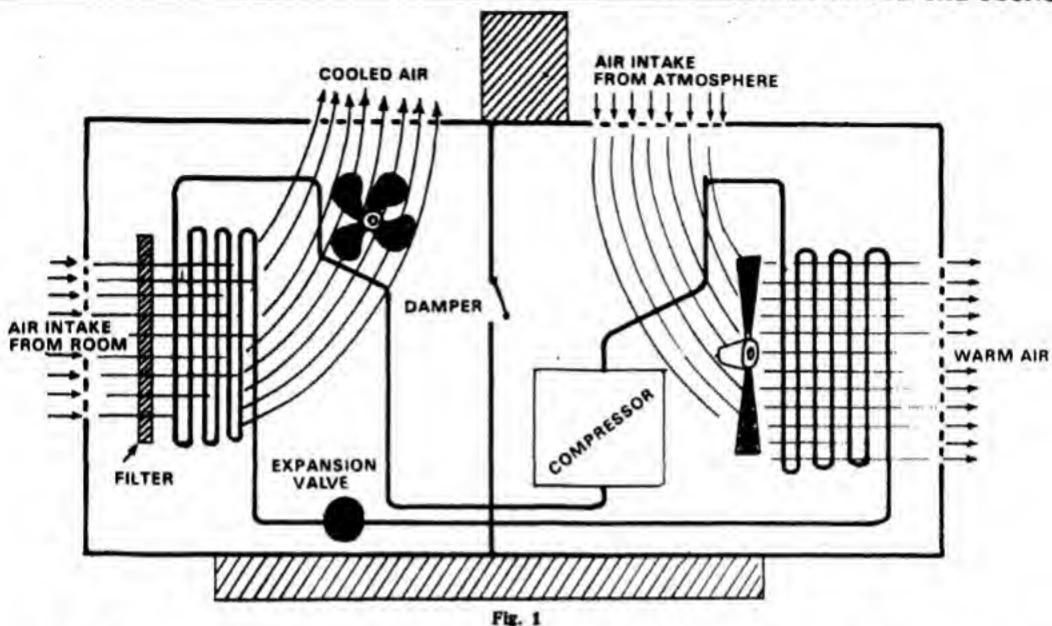
How an air-conditioner works

THE word "air-conditioner" gives a misleading impression nat of a gadget which conditions ne air, and nothing else. It is a isnomer in view of what it does. ir-conditioner is a gadget by which tmosphere can be controlled ther for the comfort of human eings or to facilitate an industrial rocess. It should have been approriate to call it "space-conditioner". he term air-conditioner was first efittingly used for the process of ontrolling various parameters of air textile industry, and not as we use today-for keeping our rooms osy for living. The term 'cosy for ving' is used here in the sense that emperature, humidity, air-flow, dust nd odours in a given space are naintained at such values as not to ffect us physiologically.

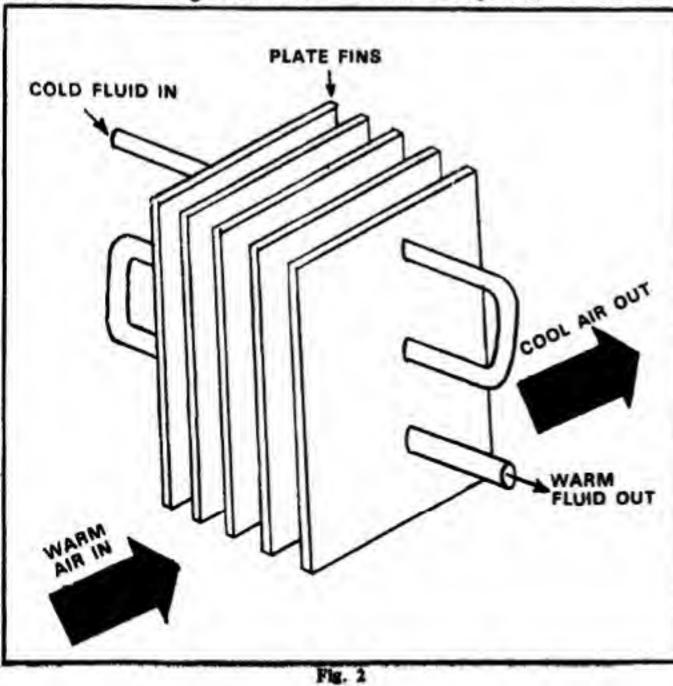
The function of an air-conditioner, as it appears to a man in the street, is simply that of lowering or raising the temperature of a given space. Its equally vital function to control humidity is not known to many. The prevalence of moisture in air is called humidity. The hotter the air the greater is the moisture it can absorb from surrounding space. At every temperature, it can absorb only a fixed quantity of moisture. When the air contains as much moisture as it can absorb at a particular temperature, it is called 'saturated' at that temperature. Air usually contains moisture less than it can hold at certain temperature. If the amount of moisture the air can hold at a temperature is taken as 100%, then whatever amount of moisture it contains at

Air-conditioners

Air-conditioners are of two kinds centralised and decentralised. I



plant located usually in the basenent of the building. Centralised air-conditioning is economical where the space is large, e.g., theatres, factories, aeroplanes, or there are

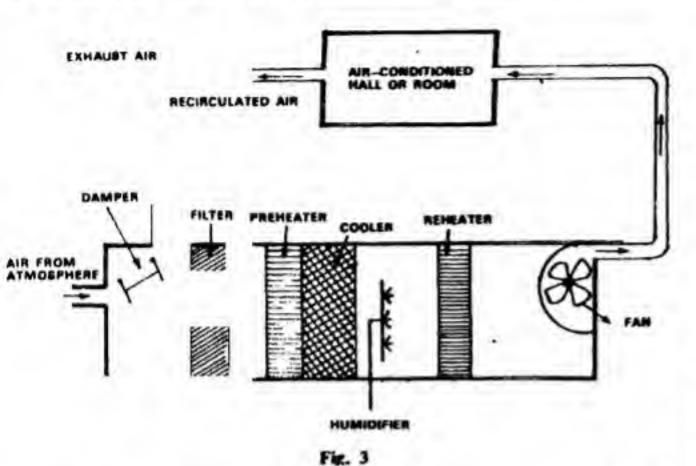


many rooms that cannot be separately air-conditioned, e.g., it offices, hotels, railway coaches Decentralised types are mostly used in homes, automobiles, etc., which obviously need separate air-conditioning.

Decentralised type. This airconditioner is a compact box. The most commonly used in Indian home is the one with a grass-mat curtain hung before a table fan. As water is allowed to seep through the curtain and the fan kept 'on', the air-flow seproduced is cool. The only disadvantage is that neither temperature nor humidity can be controlled.

An all season air-conditioner which can control humidity and temperature automatically is based on the principle of thermodynamics— her always travels from a hot body to less hot one. Such an air-conditioner works like a compression cyclinder works like a cyclinder works

The refrigerent coming from evaporator is in gaseous state at a lo



pressure and low temperature. It is compressed into liquid by compressor pump (Fig. 1). Compression of a gas produces a rise in emperature, and so the liquid proluced is at a high temperature. Why loes the liquid remain in the uniform tate, irrespective of the rise in temperature? It is because of the preailing high pressure which raises he boiling point of the liquid. The liquid at high temperature passes hrough the condenser, where the ncoming air from the atmosphere t a comparatively low temerature, absorbs the heat of he liquid, and is blown out of the onditioner at a higher temperature. The liquid further cools down brough circulation in the condenser nd is expanded by the expansion alve. The expansion produces a urther fall in temperature, and he liquid passes over to evaporator t low temperature and low pressure. t is during the circulation of this ooled liquid through the evaporator hat air of the room, after being leaned by a filter, passes through ne evaporator. The incoming air ives its heat to the liquid so as to

ne liquid into gaseous state. The

frigerant in gaseous state at a

relatively low temperature and pressure is fed back to the compressor pump. This cycle continues.

Such room-units are usually installed in windows. The compressor and condenser are outside the room, whereas the evaporator and the expansion valve inside. There is a damper 'door' also between the two chambers. By opening it, a fresh quantity of air from the atmosphere can be added to the air circulating in the room. In winter, a heater is brought into use. It heats the incoming, purified air, and the hot air so produced is mixed in right quantity with the cold air produced by evaporator. As a result, appropriate temperature and humidity are maintained in the room.

Centralised units. In this case, there is an air-conditioning plant (Fig. 3) which is connected to various rooms or points (as in a theatre or a large establishment) via ducts. The humidity and temperature of the sir prevailing in the space/spaces a automatically controlled by a hydrostat and a thermostat.

A part of the air which has alread been circulated is mixed in an appro printe quantity with the fresh a coming from the atmosphere. Suc mixture is then passed through filter, made of glass and wool, t remove dust, bacteria, etc. Cleansed it is heated in a preheater. A pre heater is a coil of metallic conduits with fins for a larger heat-exchang surface (Fig. 2); hot stream or water is circulated through the coil. Th heated air absorbs as much moistur as it can. In order to decrease th moisture content, a part of it i passed through a cooler. Coolin produces condensation of the mois ture and lowers the temperature of the air. This air is then mixed with the stream of hot air coming directly from the preheater. The quantities temperature and humidity are so controlled that the required kind o air is produced. If the air contain less moisture than required, it is treated with a fine spray of water This lowers the temperature which is not desirable. To raise it, air is passed through a reheater, and then finally passed on to a fan which blows the air through the ducts, into the rooms or hall. As a result of this constant inflow of air into the rooms, ar equal amount of air is pushed out through exhausts-from where a part of it is discharged to the atmosphere and the other part circulated back to the plant.

DILIP M. SALWI

Camphor

CAMPHOR is obtained from a large tree Cinnamonum camphora of family Lauraceae. The original homes of the plant are China Japan and Taiwan, where camphor has been produced through ages and

still is an important industry. Plant grows to a height of 30 m and girth of 2 m.

Cinnamomum camphora is cultivated best at an altitude of 4,500-6000 ft. and a rainfall of 60"-100". The plant is rown by seed as well as by cuttings, bot-cuttings, layering, and suckers. In India camphor plant is cultivated a some parts of Nilgiris, Dehradun, aharanpur and Calcutta.

Camphor is deposited in the oil ells of the plant by the activity some enzymes. These cells are istributed in almost all parts of the lant but largely in cambial region. Oil cells are formed at an early age and are filled with a yellow oil. Ifter sometime the oil volatilizes and becomes a solid white mass of amphor.

Quantity of camphor deposited is ne largest in roots. Seeds of high selding trees do not necessarily prouce high yielding plants. Plants in hady area have less camphor content han the plants in open area. Older have have less camphor content than ew tender leaves. The early practice has to distill camphor from 50 years ld trees, but at present 4-5 years old lants are mostly utilised. These days

leaves are clipped and used for camphor distillation. In India plants from Cochin (Kerala) yield more camphor than plants from any other part. The yield is 1% of the weight of the leaves and annually 60-125lb. of camphor per acre.

Solid crystalline mass of camphor is obtained by steam distillation of the leaves. Leaves are put in the copper stils with aluminium candensers. Water from condenser is decanted and camphor residue is sent for pressing first in screw press to extract the essential oil and then in a hydraulic press. The oil left is known as camphor oil.

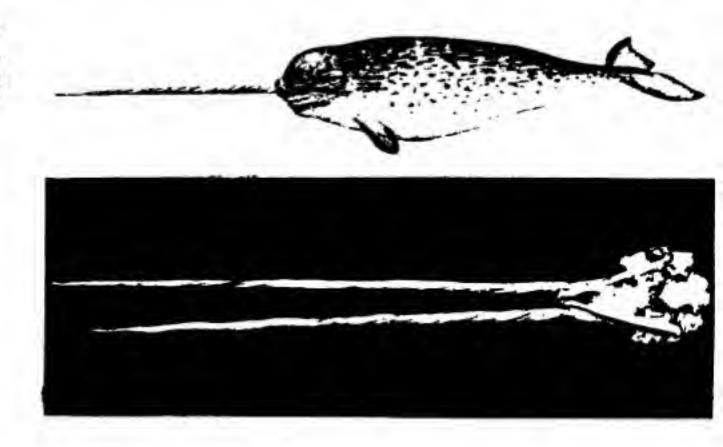
As camphor from natural source does not meet the entire demand, synthetic camphor is obtained from a-pinene, a terpene from turpentine oil. a-pinene is distilled and dried into solid bornyl chloride. By the action of alkalloids and fatty acids it gets converted into camphene and isobornyl is obtained by heating and saponification and which is oxidized to camphor. But synthetic camphor has several impurities and is comparatively inactive.

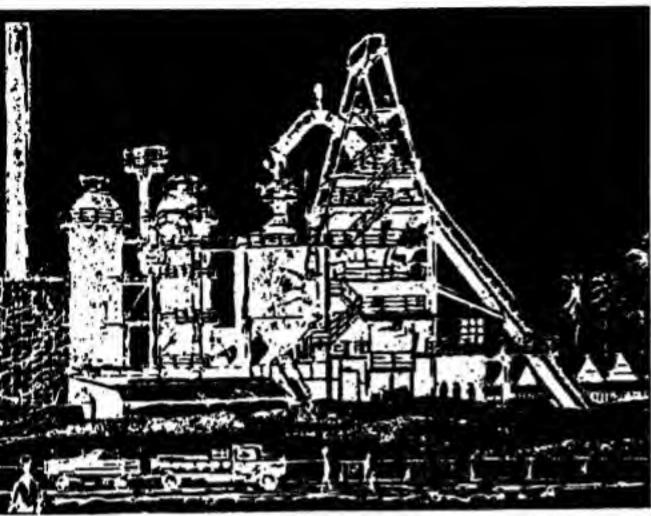
Eighty per cent of camphor is utilized as plasticiser in celluloid plastics and intracelluloid explosives. It has got its medicinal value also because of its antiseptic and anate the tic properties. It is used in the production of drugs which are in the form of pills and tablets. It is used in the depression and weakness in fever as a restorative agent in cases of los of consciousness. Injection of camphor in olive oil is given in various types of heart failure and blood circulation. It is applied in skin irritation and also used as anaesthetic.

Apart from Cinnamomum campnora, camphor may also be obtained from other plants such as Ocimum canum, Dryobalanops aromatica etc. The latter yields camphor (isoborneal which is different in properties.

NISHA BAJPA

Ref. S.R. April 1976, p. 228, correct llustration of Narwhal showing clockvise twists of the tusks is reproduced ere.





SCIENCE INDUSTRY

Patient monitoring system

THE Central Scientific Instruments Organisation, Chandigarh as developed a Patient Monitering ystem. The system continuously nonitors physiological condition f critically ill patients by meauring six parameters at one time, iz., pulse rate, respiration rate, temerature, heart rate, systolic and iastolic blood pressure. The system llows monitoring of a single or pto a maximum of six patients by hanging modules for different paraeters.

A bedside unit, it is mounted on atient's bed. Each physiological arameter is measured by a suitable ansducer attached to the patient. he signals from the transducers are ed to the bedside unit, where, after rocessing, they are transmitted arough cables to the display unit.

Specifications of Patient Monitoria System

Pulse rate 0-250 per min Respiration rate 0-50 per min Temperature inside and outside body 32-42% Systolic b.p. 0-250 mm of H Diastolic b.p. 0-250 mm of H Heart rate 0-200 per min TV waveform display unit Sensitivity 20 mv pr Input impedance 1 Mcg Ohn Band width DC to 10 kHz

Dynamic range

Time base

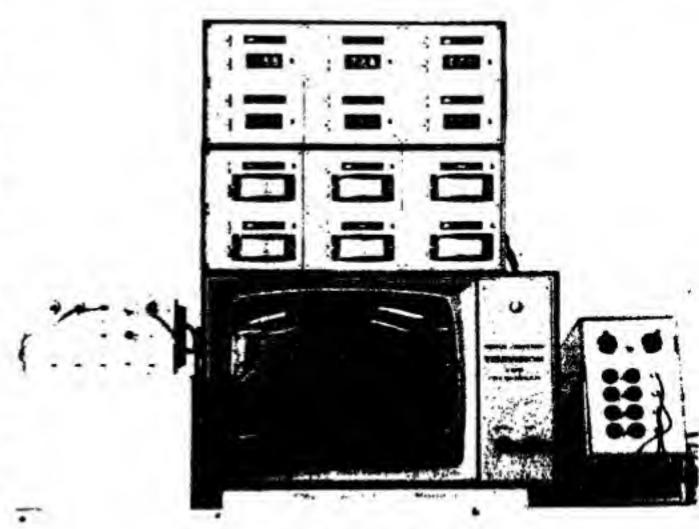
1,5,10 and 20 sess Triggering Free running, positive and negative ed triggering

20 mv-2V pr

The bedside unit has five channel which are interchangeable.

Display unit continuously indicate the average rate of all the six para meters either on different meters or o digital display tubes (Nixie tubes) Provision is made for setting higher and lower limits of each parameter Whenever the value of a paramete departs from preset limits, audio visual alarm issues a warning.





The waveform of physiological arameters are displayed on four odentical channels 47.5 cm TV tube creen. TV waveform display unit an also be used in industry in connection with suitable transducers for pultichannel display, viz., flow. ressure, vibration and turbulence. The complete system has been esigned on modular concept and

universal interchangeability. The design of the circuitry employs integrated circuits for greater reliability. Care has been taken in the design to make the system safe. The instrument developed uses in digenously available components, materials, etc. except for blood pressure transducer which is imported.

Harmless chemical for farms

Zinc dust

THE National Metallurgical Laboratory Jamshedpur has successfully developed and transferred the rocess technology for producing igh grade extra fine zinc dust containing 96% metallic zinc by distillation process, the fineness being all selow 44 microns.

The process has been leased to a cading industrialist of Calcutta, who as already started trial production franc dust since November 1975. Another plant consisting of 5 to units to produce 1500 tonnes of zinc dust per annum is at dityapur in Jamshedpur and the ame licencee is planning another unit in the industrially back-ward area of Ratnagiri with the active essistance from SICOM.

The NML prototype unit had been

successfully run for process provingdemonstration and training of licencee and over a half tonne of NML produced zinc dust had been sold to the licencee at prevailing market rates for initial sale to their customers. The product fully meets ISI specifications. Raw materials usable are galvanizers' dross and Zamak die-casting scrap apart from ingot zinc metal.

The zinc dust demand for hydrosulphte industry alone is over 5000 tonnes per annum. Most of this is being imported involving foreign exchange of over Rs. 6 crores, since distilled grade zinc dust is not yet produced in India. This is likely to be eliminated, sooner the indigenous production capacity is built up.

THENTHOATE is an important organo-phosphorus insecticide broad-spectrum activity having various crop pests o against rice, cotton, vegetables, fruits, ter and tobacco as well as against mos quitos. Since it has a low mamma lian toxicity, it is safe to handle and leaves no toxic residues after use. A process for the manufacture of phen thoate has been developed at the National Chemical Laboratory Poona. A firm has erected a 30 TPA plant on Thana-Belapur road This was commissioned in December 1974. During 1974-75, the firm pro duced 5 tonnes of phenthoate which valued around Rs. 3 takhs. Th annual turnover of the plant, whe in full operation, will be approxi mately valued at Rs. 2.2 crores.



ROMOLECULES: STRUCTURE, PROPERTIES AND FUNCTIONS by Dr. A. Sankaran, The Bangalore Printing & Publishing Co. Ltd, Mysore Road, Bangalore-560018, 1974, Pp. 213, Rs. 14

A following criteria: (i) it should rovide source material and suppleent material for those who cannot or various reasons attend regular lasses; (ii) it should have all the iformation needed for an underlanding of the subject covered; ii) where a topic is touched upon nly in passing, further indications rearding the topic should be indicated learly, (iv) wherever possible, it hould give the student a chance for elf-evaluation by including questions nd problems at the end of each hapter; (v) it should be addressed the demands of a particular class f students: graduate, post-graduate, rofessional, etc.; and (vi) it should lso help the student to prepare for is or her examinations. But even all nese would not suffice. A good text ook should serve as an inspiration or a student who is to be initiated nto the intricacies of learning of a ew subject-its idioms and grammar -a companion in the joys and thrills f acquiring knowledge.

The task of writing a text book hich fulfill all the above requirements wor I be a Herculean one ideed! But then there are but few book text books in any given subject. Ince they appear on the scene, they ontinue to inspire and guide students

for many years. They become classics of a sort.

To some extent the above tasks are further exacerbated in dealing with a topic like structural biochemistry, which is intrinsically multi-disciplinary. The problem that faces the author is to decide where to begin with. The difficulty is best reflected in the book under review. It is obviously not an easy task to build up in the same book from outlining the need to study organic chemistry as a separate subject to a discussion on an advanced topic like allosteric enzymes. This, compounded with the fact that the book aims at a compact size, has introduced certain distortions which are understandable nevertheless regrettably. The lucidity of presentation which the author has achieved while dealing with sections on vitamins, carbohydrates, etc., is unfortunately not so perceptible in earlier sections. earlier sections on alcohols, aldehydes, ketones, acids, etc., have been dealt with in a perfunctory manner. An example of this would be Table 2.5 which summarises the sub-section on aldehydes and ketones with hardly any textual elaboration. Either the author should have assumed that the students (or users of the book) are familiar with these elementary topics (so that he could have paid more attention to later topics) or devoted more space to these sections. Further, to assign only two or three reasons why organic chemistry deserves the status of a separate subject, as done in the first chapter of the book, is treating matters too casually. If at all the author felt the need to dwell on the subject, he ought to have been more elaborate about it, or at least referred the readers to other works, which deal with this problem in some detail.

Unfortunately, there are certain avoidable mistakes in the book which are not necessarily serious per se, but do attract the attention of the reader. The mistakes are of three types:

1. Spelling: Meischer being spelt

in two different ways (page 14 and page 165).

English: more simple being used instead of simpler (page 8)

3. Structure: C-H

o
instead of -C-H

(Table 2.2, page 9, col. 2).

In some places, ideas have bee arbitrarily introduced without an previous references, e.g., the concep of nucleophilic addition reaction (page 25).

Despite these drawbacks, th author's attempt is an useful and, to some extent, successful one. Som errors have been pointed out here i the hope that in future editions thes may be avoided. The author obvi ously has put in a lot of effort in bringing out this text book, which should meet the demands of agri cultural chemistry students in ou country. But one wonders wha lasting impact will this book have or teaching of this subject in this country The book is too much directed towards the examination and too little towards the understanding and appreciation of the subject.

> C.V. SWAMINATHAN Planning Division CSIR, Rafi Mary New Delh

ENERGY FOR SURVIVAL, THE ALTERNATIVE TO EXTINCTION by Wilson Clark, Doubleday & Co. Inc., 277 Park Avenue, New York, N.Y. 10017, U.S.A., Pp. 670 \$4.95

THE price at which this bulky volume is available makes it one of the most sought-after publications on energy crisis with its virtually encyclopaedic contents. It index runs into nearly 20 pages while its annotated reference chapter cover 45 pages indicating the exhaustive work under-taken by the author in collecting this

naterial. As he rightly puts it, energy onservation policies will be necesary on a massive scale to forestall hortages of both energy and mateal goods in the economy in the years come. A currently popular notion that energy crisis will disappear if a ation like USA invests heavily in ew technologies like nuclear fission, r develops 'synthetic' liquid and aseous fuels from deposits of solid ydrocarbons such as coal and oil hale. In fact the energy required to ring more oil, natural gas and coal rom the earth into use may many mes turn out to be more than the nergy in the fossil fuel reserves nemselves. For example, 12,600 Wh of thermal energy is required or producing one ton of steel; 7,200 kWh for one ton of aluminium, 2 kWh for coal, and 2900 kWh for lastics.

It is pointed out that the most eavily subsidized energy technology to USA is nuclear fission, a proess which the author believes has oubtful energy gain and woefully nadequate safeguard against environmental pollution. This concept may not be shared by all readers espeially nuclear technologists and adustrialists who have sunk their noney in nuclear energy.

The author advocates solar energy s an abundant, safe and practically ollution-free form of energy reource. As such, nearly half of the ook is devoted to energy from the un in all its various ramifications. he other half gives a lucid analysis f energy resources available and pplicable from fossil fuels, oil, coal, uclear fission and fusion, and the ewly developing sources like MHD. ydrogen, geothermal sources, tides nd wind. It is a pity that hydel ower is disposed off in just seven ages, without giving it importance, erhaps because in the USA hydroower accounts for only 2% of the ation's energy as against 43% of energy coming from oil, 33% from natural gas and 20% from coal.

Prepared from various sources, the author gives a table of parameters of non-renewable natural resources, such as their global reserves, their growth rate, countries having highest reserves, etc. The most informative item is the 'Static Index', that is, the number of years these reserves will last at current rates of global usage.

It is shown that coal will be available for another 2300 years, chromium 420 years, iron 240 years, aluminium 100 years, gold just 11 years (smugglers be on their guards!), natural gas 38 years, and petroleum 31 years.

Another facet of the problem discussed by the author is the decentralisation of America's electrical generating and distribution system which when fully operative will bring substantial overall savings. On the question of producing weapons grade plutonium, the author is rather critical in his approach when he states that "Both India and Japan are constructing reprocessing plants which would allow them to build weapons if they desired" (p. 304).

Interesting highlights are given on the Indian scene regarding solar cookers and bacterial bioconversion of wastes by giving the examples of work done by Harold Hay of Los Angeles, California, and Ram Bux Singh. Hay is credited for building a small house for the Government of India in 1950 by using new materials giving good insulation at low cost. Ram Bux Singh is said to have built thousands of bio-gas plants to provide fuel and fertiliser for the people of this country. Singh's work has generated an upsurge of interest in methane generating system in the USA. It is not known whether Singh is currently in India or in the USA since the author's references pertain to Singh's books on the subject available from The Mother Earth

News (P.O. Box 70, Hendersonville, N.C. 28739, USA). Unfortunately no mention is made of gobar gas plants on which considerable interest is being generated in India.

The concluding section on wind power gives interesting facets of this natural energy source. The World Meteorological Organisation has calculated that 20 billion kW of power expressed in electrical capacity are available from winds at various locations on the earth.

Nuclear fusion, which is discussed and disposed off in a few pages somehow does not create an impact Currently laser-induced nuclear fusion appears very close to solving the world's oil, gas and coal depletion problems. This concept utilises deuterium which abounds in secure water: It is estimated to be sufficient to provide for the world's energy needs for 350 million years.

Whatever be the author's views biased to some extent as they may be—he has produced a really good piece on energy crisis which should interest readers from all strata of society.

S.K. GHASWAL

TEXT BOOK OF SOCIAL MEDICINE by B. Sridhar Rao, Mrs. Sudha Sridhar (Publisher), A-4
J. N. Medical College Quarters
Belgaum-590010, 1976, Rs. 25; £3.

The book under review is the first text book by an Indian author on this subject while a number of books of preventive medicine are in existence. The book is divided into six parts each starts with an introduction followed by a detailed account of the subject. At the end of each starts with an introduction followed by a detailed account of the subject. At the end of each starts with an introduction followed by a detailed account of the subject. At the end of each starts with an introduction followed by a detailed account of the subject. At the end of each starts with an introduction followed by a detailed account of the subject. At the end of each starts with an introduction followed by a detailed account of the subject.

napter a short bibliography is iven.

The book covers a wide range of pics: the social factors in diseases general, social factors predisposing specific group of diseases, the relaon of social factors to certain social flictions, beneficial social factors, ocial consequences of diseases and iscellany. Do social factors preispose men to diseases? Yes! Diseases result from the operation ot of a few but of multiple causes; ome of these no doubt are social thers are physical and biological". onsequences of alcoholism and drug ddiction are highlighted in this book. mong the other chapters, the relaonship of emotional stress on health ith questions such as what causes motional stress are discussed. Malractices in food and drug adulteraon and quackery with their harmful onsequences arouse social conscious What is lacking is the Indian CSS. ene of these problems. But as a ext-book meant for basic information n the subject this objection is not bsolutely valid.

The reviewer agrees with what rof. Banerjee, Director, All India institute of Hygiene and Public lealth, Calcutta, says in his foreward this volume will also be useful for the teachers of preventive and social medicine of Indian universities."

ZAKA IMAM

UNDERSTANDING PHYSICAL CHEMISTRY VOL. III by P.L. Soni and H.C. Sharma, Sultan Chand & Sons, Daryaganj, New Delhi-2, pp 214, Rs 6.50.

The volume under review is one of the series of books which are the programmed supplements to a textbook on physical chemistry dealing with objective type questions. The questions are graded and presented in a manner to help students comprehend the subject step by step by self-learning. The present volume discusses thermodynamics, atomic structure (i) and (ii), periodic table, isotopes and nuclear chemistry.

As thermodynamics is a subject difficult to understand without clear fundamental concepts, the authors have succeeded to some extent in making it understandable through a large number of solved objective type problems at the end of each chapter. They have discussed briefly all the three laws of thermodynamics, and the relation between energy and the equilibrium constant has also been derived. Concept of 'system' and its nature have neither been touched upon nor the nature of 'work' done by the system on the surroundings or vice versa. The second law of thermodynamics should have been discussed in more details, as the significance of its concepts cannot be overlooked.

The chapters on atomic structure

(i) and (ii) deal with elementar discussion on the subject introducing the wave particle duality of electron Quantum numbers and electron configuration in many electron atom have been discussed. The ne chapter gives the concepts involve in modern periodic table, and phy sical and chemical properties atoms based on their electron configurations. Elementary discu ssion on isotopes and a few method of their separation are included i the chapter on isotopes, whereas n emphasis is laid on the principles of separation techniques.

The chapter on nuclear chemistre mentions nuclear stability and radio activity. Radioactive series, 4n+should have also been included to make the description complete Nuclear reactions are not fully covered to the extent required this typof book.

Merit of the book lies in that ever chapter is enriched with a larg number of graded objective type problems which help aquire thoroug understanding of the subject. A summary of the subject-matter is als included in each chapter.

The book will prove helpful to B.Sc. students, and to those who tak competitive examinations.

H.O. GUPT

Research Associate

Deptt. of Material Science

I. I. T., Kanpu

FOR SURE SELECTION IN I.I.T.

Read ARUN'S GUIDE

For

INDIAN INSTITUTE OF TECHNOLOGY

(ENTRANCE EXAMINATION)

A guide book covering the complete syllabus as prescribed for the entrance examination of L. I. T. and also based on previous years' question papers fully solved.

1st Edition 1976

Price Rs. 20.00

YOUNG MAN & CO.

888 NAI SARAK, DELHI-110006

Phones: Delhi 263298 Jaipur 73972 Bhopal 2500

Copies available with all the leading book-sellers or send your orders direct to the publishers with an advance of Rs. 5.00 by M.O.

INDISPENSIBLE BOOK

FOR

MEDICAL ADMISSION TEST OF

POONA, U.P., A.P., M.P., VELLORE PONDI-CHERRY, VARANASI, ALIGARH, BIHAR, ORISSA, BANGALORE, MYSORE, ETC.

OBJECTIVE GUIDE

INCLUDING

MULTIPLE CHOICE, THOUGHT, NUMERICAL AND QUESTIONS OF VARIOUS MEDICAL TESTS

Price: Rs. 25.00

Postage: Rs. 2.00

POPULAR BOOK STORES

OPP. PATNA COLLEGE PATNA-800004

FOR MEDICAL ENTRANCE TESTS

Read

ARUN'S GUIDE

For

MEDICAL COLLEGES ENTRANCE EXAMINATION

Containing

Objective & Thought Type Questions

POONA. A.F.M.C. C.P.M.T. (FOR ANDHRA PRADESH, VELLORE, VARANASI. BANGALORE, PONDICHERRY.

BIHAR, ORISSA, ETC.)

7th Revised Edition 1976

Price: Rs. 22.50

and

LL INDIA INSTITUTE OF MEDICAL SCIENCES

(Entrance Examination)

Containing

Short Answer & Essay Type Questions (ALSO USEFUL FOR WEST BENGAL, ALIGARH, M.P., WARDHA, RAJASTHAN AND MEDICAL COLLEGES OF DELHI, ETC.)

Published by:

Price: Rs. 21.00

YOUNG MAN & CO.

888 Nai Sarak, Delhi-110006

IT PAYS

TO

ADVERTISE

IN

SCIENCE REPORTER



From Alchemy to to-day's Science

Alchemy began by an obsessive urge for transforming the baser metals into gold. The experiments of Alchemists recorded under mystic terminology, gradually led to the discovery of metallic arsenic, antimony and phosphorus.

We at Sarabhai M. Chemicals have the obsession of alchemists, not for producing 'Philosopher's Stone' but for providing an ever increasing range of ultra high purity and trustworthy laboratory reagents—the tools of modern chemists.



SARABHAI M. CHEMICALS

Where scientific tradition of ingenuity never dies.

Shilo 2 SM 13/74

SCIENCE REPORTER



WHAT ARE DREAMS?



Re. 1.00

COUNCIL OF SCIENTIFIC & INDUSTRIAL RESEARCH NEW DELHI-110001

MAN MADE TO ORDER-GENETIC ENGINEERING

THE STORY OF CRYSTALLOGRAPHY

PERILS FROM POLLEN

MATHEMATICS IN NATURE

KILLER SHARKS IN THE INDIAN WATERS

OL technology takes us on to tomorrow.

Many years ago IOL pioneered the nanufacture of oxygen and other gases in ndia. The technology associated with their ise has ushered in a revolution for many ndustries.

As world technology developed, IOL kept pace Advanced welding techniques such as submerged arc welding, TIG and MIG weldng and the necessary equipment, as also ully automatic welding machines. Sophisticated cutting machines such as the solid state control gas cutting machine and the adial arm shape cutting machine. Electrodes or welding thick armour plates and stainless iteel tubular hardfacing electrodes for proonging the life of machinery in thermal power stations and other heavy engineering ndustries. Gases of extra high punty, with specific impurities reduced to certified levels, now produced in the IOL Special Gases Centre, for development and growth of electronics, research and other specialised ields in the country. Complete pipeline sysems for the distribution of gases. And then, entire gas plants and cryogenic equipment. All these and many more IOL has introduced

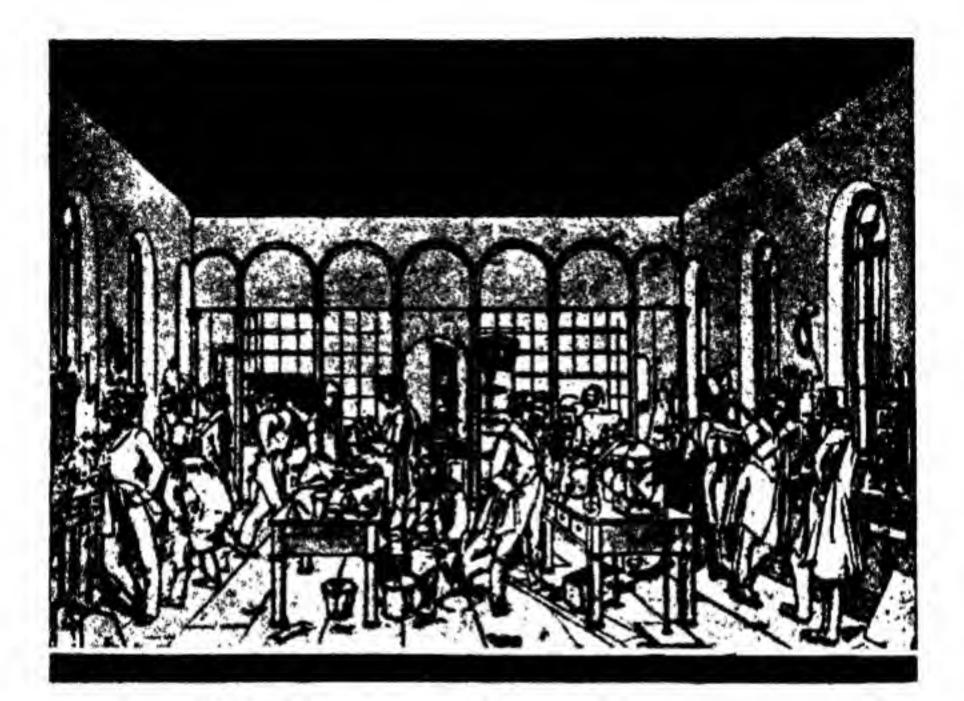
In fields as diverse as steel-making and ood preservation, metal joining and fertilisers, electronics and anaesthesia, space ocketry and pollution control-IOL is work-

IOL is technology



IIII Indian Oxygen Limited





Where the Pioneers have left

The key nature of alchemists role in laying the foundations of modern science, may be judged from only a partial list of basic scientific tools, associated with their names.

Chemistry had its origin in the laboratories of the alchemists. Alchemy eventually expired under the impact of science, but its tools and procedures were taken over by the scientists in the modern world, to utilize them for extending the basic discoveries still further and bringing them closer to the common man.



SARABHAI M. CHEMICALS

Where scientific tradition of ingenuity never dies.

to our contributors

- SCIENCE REPORTER welcomes articles of absorbing interest on science and technology. Contributions
 published in the Journal will be paid for.
- Articles should be sent to the Editor, SCIENCE REPORTER, CSIR, Rafi Marg, New Delhi-110001.
- The form and manner of presentation of the subject should be easily understandable to the undergraduate level.
- The length of the article, written exclusively for the Journal, may be about 2500 words.
- The matter should be typewritten, double space on one side of the paper; the original and a carbon copy are to be sent.
- The article should preferably be illustrated; captions and legends typed separately and attached at the end of the article. Photographs should be on glossy paper.
- While quoting names of scientists, etc., their initials, nationalities and periods of research under reference should invariably be mentioned. All weights and measures should be given in Metric Units.
- A short note about the contributor should also accompany the article. The note should contain age, academic accomplishments, important assignments held, fields of research and hobbies.
- Articles or illustrations published in the Journal can be reproduced with permission of the Editor.
- The Editor reserves the right to reject even invited articles without assigning any reason.

SU	BSCR	IPT	ION
FO	RM		

To

The Editor SCIENCE REPORTER C.S.I.R., New Delhi-110001

Name	
Full Address	
(in capitals)	
PIN	
(Old Subscription No)	Signature
NOTE: Please mention old Subscription No. in M	I.O. compon also.



VOL. 13 JUNE 1976

NO. 6

324 LETTERS

326 PLANETS AND THEIR POSITIONS—JULY 1976

MAIN ARTICLES

327 The mystery of dreams Mahdi Hasan

333 Genetic engineering Keshav Trehan

337 The story of crystallography G.D. Nigam

342 The jointless railway track S.K. Bhatnagar

346 Ion exchange membranes and their applications S.S. Dara

350 SCIENCE SPECTRUM

Double radio sources—Pi in terms of a new fraction—Does polywate exist?—Synergistic phenomena—Disc electrophoresis—Perils from pollen—Vegetable meat—Algae cause allergy—Killer sharks in Indian seas

367 NEWS AND NOTES

Polyvinyl chloride and birth defects—Environment engineering-Third National Convention 1977

368 MEDICAL NOTES

A new approach to cancer therapy—Vitamin C prevents rabies—Correct constipation with roughage—Bacterial pathogenicity

372 SCIENCE FOR THE YOUNG

How headlights of a vehicle work—Mathematics in nature—Of birds and plants—Fun with geometrical figures

377 SCIENCE IN INDUSTRY

Electronic torque wrench—Cardiac monitor—Night soil digester

380 BOOK REVIEWS

Thorium: Physico-Chemical Properties of its Compounds and Alloys-Modern Physics—Plant Pathology-Theory and Practicals—Plant Science First Course in Group Theory—Printed Circuit Troubleshooting

Annual Subscription

cience Reporter is Issued monthly. he Council of Scientific & Industrial

escarch assumes no responsibility of the statements and opinions

ivanced by contributors.

nland ; Rs. 10.00

Foreign: \$ 5.00 Editorial Staff: Dilip M. Salwi, Nisha Misra Sales & Advt.: G.N. Jaswal, G.E. Salpek

Production: V.S. Chaturvedi



Diet for diabetes

Sir, Is rice taboo for the diabetic?

S. R. Nov., 1975) by A. Ramachanlran and M. Vishwanathan was
lighly informative. I would like
to know how Bengal gram helps
revent atherosclerosis. Does it
leduce serum cholesterol when
laken by a normal healthy man?
It is mentioned that diet for a dialetic should be rich in carbohylrate and proteins but should be
light in fats. Will blood sugar not
increase as a result of carbohydrate
liet?

JAWAHARLAL AGARWAL Medical College Burla (Orissa)

1. Bengal gram has some hypocholesterolemic effects.

References

- i) Mathur, K.S., Khan, M.A., and Sharma, R.D. (1968), Hypocholesterolemic effect of bengal gram: A long term study in man.
- ii) Mathur, K.S. (1972), Prevention of atherosclerosis: An experimental study, Journal of the Association of Physicians of India, Vol. 20:197.
- A diet rich in carbohydrate nd proteins with restricted fat will ot increase blood sugar if total alories is restricted.

N. VISHWANATHAN
Director, Diabetes Res. Centre
Madras

Plant diseases

Sir, I appreciate Paul Khurana or his article Why do insects carry lant diseases? (S.R. Feb., 1976). The article is quite informative but the title given by the author is confusing. I would like to make it clear that disease is a symptom produced as a result of interaction between the pathogen (may be virus, bacterium, fungus, etc.) and the host. So only pathogens are carried through insects. Diseases are not caused by insects.

N.S. BUTTER

Department of Entomology

Punjab Agriculture University

Ludhiana

Actinides

Sir, I thank S.S. Dara for Rare earths—a fascinating group of elements (S.R. Feb., 1976). He has explained beautifully the occurrence, processing and application of lanthanides.

Kindly publish an article on 'actinides' for the benefit of students preparing for competitions.

BRAJENDRA MISHRA .
5, Hostel, G.I.C., Allahabad

Biomembrane

Sir, I read with interest Biomembrane (S.R. Jan., 1976) by Ramakrishnan.

While describing the function of biomembrane, specially pump, one cannot overlook the role of Ca*+ pump in membrane system called sarcoplasmic reticulum which plays a vital role in the regulation of muscle contraction. Like Na+-K+ pump system of biomembrane, this membrane system has Ca2+ pump system which regulates the Ca* ions concentration surrounding the contractile fibres of muscle. At rest, the Ca2+ ion is pumped into the sarcoplasmic reticulum so that the concentration of Ca2+ ions around the muscle fibres is very low. Excitation of the sarcoplasmic reticulum membrane by impulses leads to a sudden release of large amount of Cast ions.

The transport of Ca²⁺ by sarcoplasmic reticulum is driven by the hydrolysis of ATP. The enzyme responsible for the hydrolysis

Ca²⁺ dependent, and is tight
bound to the membrane. The
Ca²⁺-ATP is an integral part of
the Ca²⁺ pump, just as the Na²⁺

K⁺ ATP in sodium-potassium pump
The Ca²⁺ ATP is also phosphory
lated by ATP as shown below:

En + ATP Cas+Mgs+ En P + ADI

En, "P+H,O→En,+Pi
Two Ca++ ions are transporter for each ATP hydrolysed. The maximum Ca++ pump rate is about 10 sec-1. P.S. Stewart and D. H. MacLennam (1974) of the University of Toronto, Canada has characterised the molecular properties of Ca++ ATPase on SDS polyacrylamide gel. They found that the enzyme moves as a bigger protein molecule with a molecular wt. 100,000 Dalton.

SUDHIR KUMAR SRIVASTAV

Department of Zoology, Benara

Hindu Universit

Varanasi-22100

Mathematics

Sir, Martin Gardner in his boo Mathematical Puzzles and Diversions writes:

"I have been told by Piet Hei that whenever he visited Albe Einstein he found a section of Ein stein's bookshelf stocked wit mathematical games and puzzle The interest of these great minds i mathematical play is not hard t understand, for the creative though bestowed on such trivial topics of a piece with the type of thinkin which leads to mathematical an scientific discovery. What mathematics, after all, except th solving of puzzles? And what i science if it is not a systematic effor to get better answers to puzzle posed by nature?"

To cite an example: Using only a straight edge and a compass and with all the time in the world, how can you trisect any angle?

There are people who occasionall leave work to square a circle of

isect an angle. They are wasting heir time; both these geometric roblems have long since been roved impossible to solve. It cannot e done without trickery. Yes, creational mathematics, of course, fun.

I would like you to publish articles n the recreational mathematics nder a permanent section in S.R.

> UMA KANT SHARMA P.G. scholar in Mathematics Lucknow University

Computer

Sir, This letter has reference to Ramaswamy's article Languages omputers know (S.R., July 1975) and lagaraj's discussion in S.R. Jan., 976.

Nagaraj pointed out some errors n the computer program written by Ramaswamy. Even with the correcions given by Nagaraj, the program vill not work because after executing he line No. 12 of the program it will print all the days. Hence we have to nsert after each 'WRITE' statement, 'GO TO' statement. Then only, fter computing the correct day, he program will print the unique lay.

N. SUBRAMANIAN SRF (CSIR), 11T, Madras 600017

Mushroom

Sir, Apropos of Natarajan's letter (S. R., Jan. 1976). I have to add some more information.

The paddy straw mushroom is a tropical mushroom which comes up well almost throughout the year in South India and in places where the minimum temperature does not go below 25°C. This mushroom is grown at our institution farm and spawn is supplied to interested growers.

The mushroom grown in Nilgiris and Kodaikanal is different from paddy straw mushroom. It is Agaricus, which is a subtropical mushroom. It is grown in wooden trays; it takes 2 to 3 months to get a single crop, whereas the paddy straw mushroom comes up in 12 to 15 days.

> C.S. KRISHNAMURTHY Scientist (ICAR) (Retd.) Paddy Straw Mushroom Project Tamil Nadu Agril. Univ. Coimbatore-3

Suggestions

Sir, The Science Reporter is a journal for all, and specifically for

science students. It provides good amount of reading matte covering many fields of interest However, in the last few years, then has been a repetition of article on 'Photosynthesis', 'Respiration' etc., without adding much nev information. Articles on brain a a computer, mechanism of thinking sleep, dreams and robots, and othe recent developments in scientifi fields are awaited.

> RAVINDRA K. RAGHUVANSH Lecture Botany Depti University of Rajasthan, Jaipu

> > П

Sir, In the article Plants too hel responsible for pollution (S. R. Dec. 1975) the botanical name of per plant is misprinted as Pinus sylves tris. It should be Pisum sativum.

The article Nitrogen fixation by any plant is possible (S.R. Dec., 75 was informative and interesting. would like you to publish an article on 'phytohormones'.

> ANIL K. JAIL Lecture Dept. of Botan K.L.D.A.V. Degree College Roorke

SCIENCE FOR THE YOUNG (Continued from page 376)

minimum number of continuous moves will be half of the number of odd-vertices in the figure.

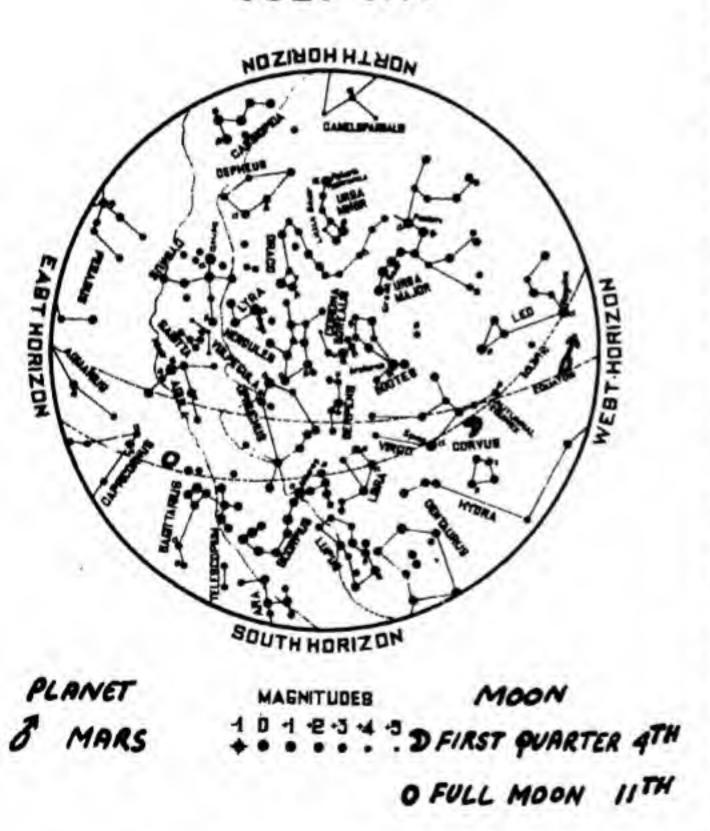
If (n) is any positive integer and if he given figure has (2n) number of

number of continuous moves required odd-vertices (which are always even minimum continuous moves to com to complete it. In every case the as indicated above), the minimum plete the figure. number of continuous moves of the pencil will be (n), but it will have to be raised (n-1) times. So, by knowing the number of odd-vertices in any figure we can know the number of

SUCHITRA GUPT Hindu College, Moradaba (Uttar Pradesh

Planets and their positions

JULY 1976



The moon

Full moon occurs on 11th at 6-39 .m. and new moon on 27th at 7-09 .m. 1.S.T. The moon passes about a degree south of Mars in the vening of 1st, about half a degree outh of Jupiter on 21st, about seven egrees south of Venus and Mercury

on 28th and again about five degrees south of Mars on 30th. The lunar crescent becomes first visible after the new moon day in the evening of 28th. The moon is at perigee or nearest to the earth on 7th and at apogee or farthest from it on 19th.

The earth is at aphelion or farther from the sun on 3rd.

The planets

Mercury (Budha), a morning startises about an hour before sunrisduring the first quarter of the month. Thereafter, it is too near the sun to be visible. It is in superior conjunction on 15th. At the fag end of the month it reappears as an evening star an sets about an hour after sunset. It moves from Taurus (Vrisha) to Le (Simha) through Gemini (Mithundand Cancer (Karkata). Its visual magnitude varies from—0.7 to—0.5

Venus (Sukra) is too near the su to be visible during the first half of the month. Thereafter, it reappear as an evening star and sets about half an hour after sunset. It move from Gemini (Mithuna) to Cance (Karkata). Its visual magnitude about — 3.4.

Mars (Mangala), visible in the evening sky, sets about three hour after sunset during the first half of the month and about two hours after it during the second half. It passes about half a degree north of the star Regulus (Magha) on 5th. It is it Leo (Simha). Its visual magnitude is about +1.9.

Jupiter (Brihaspati), visible in the morning sky, rises about one and half hours after local midnight during the first half of the month and about half an hour after it during the second half. It moves from Aries (Meshoto Taurus (Vrisha). Its visual magnitude is about — 1.8.

Saturn (Sani), visible in the evening sky, sets about an hour after sunse during the first quarter of the month. Thereafter, it is too near the sun to be visible being in conjunction of 29th. It is in Cancer (Karkata). It visual magnitude is about +0.5.

(Source: Nautical Almanac Un of the Meteorological Office, Alipore Calcutta-700027) Dreams can reflect many sides of an individual's personality is interests, experience, his store of knowledge, the order and ature of his emotions, etc.



MAHDI HASAN

NE spends about one-third of one's life sleeping. Out of his nearly one-fifth to one-fourth occupied by dreams, according to the German physiologist, U.J. ovanovic (1975). In other words, y the time we celebrate our sixieth birthday we should have slept over for some 20 years. This time seriod ordinarily includes 4 to 5 tears of dreaming.

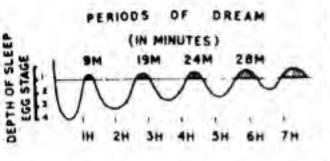
listorical background

From ancient times people have een interested in what dreams are nd their relationship to reality. The incomprehensibility of dreams hade people look upon them as omething supernatural, mysterious or even prophetic. Socrates spoke of the divine and prophetic nature of dreams. Quite another point of view was that of the materialistic philosopher of ancient Greece, Democritus, who held dreams to be the continuation of the automatic activity of the brain in the absence of perception. Aristotle in his treatise on Dreams and Their Interpretations explained dreams as being a natural manifestation of brain activity. He called dreams as "echoes" of perception obtained in the waking state. In his monograph on Man, his Morality Immorality, the Russian I. Radishchev, spoke of the formation of dreams under the

influence of external and internationally connected with the period of falling asleep and awakening Ivan Pavlov, the renowned physic logist, defines dreams as a combination, "in a most unexpected manner", of the traces of former stimuli received by the brain. No withstanding the progressive character of these ideas on the nature of dreams, they were at best on speculative, blind but bold guest work not based on precise scientific data.

We can judge dreams by the recollections of people who rement ber them upon awakening. A indirect indication is also the behaviour during sleep. Remember the

Shri Hasan is Prof. of Human Anatomy, Brain Res. Lab., J.N. Medical College, Aligarh Muslim University.

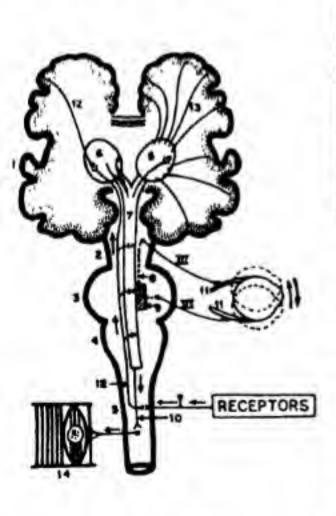


g. 1. Periods of dream during 7 hours sleep. (Maminute, Hahour)

appy smile on the face of a child tho is dreaming of something very cleasant, or how a sleeping person aving a nightmare groans and wists.

Vhat are the sources of dream?

One source of dream may be timuli arriving from the outer world. These stimuli in a distorted orm are percepted by the light leeper. For instance, take a peron asleep at home near a summer



rain-mechanisms for dream. (1) Cerebral remisphere, (2) Mid-brain, (3) pons, (4) Medulla oblongatu (2 + 3 + 4 + Brain stem). Spinal cord, (6) Thalamus, (7) Recticula's formation, (8) Medial longitudinal fasciculus, (9) Medial vestibular nucleus, (10) Recticulopinal tract. (11) Muscles of eye-medial ectus, lateral rectus, (12) Specific thaia nocortical pathway, (13) Diffuse thalamorotical projection, (14) Muscle spindle regulation of muscle tone).

Nature of dreams

T7HILE dreaming, one's control of attention, judgement, imagery and other mental functions are considerably reduced. The sequence of events in a dream becomes bizarre; the dreamer is a passive observer of events passing through his mind. The dream is not only visual but is of a variegated nature, predominantly interwoven of visual and auditory imageries. However, images in dream are mostly gray not coloured or chromatic; the cause of general lack of coloured images in dream is not those known. In dreams, only imageries are expressed which one has experienced in waking life. Therefore, persons devoid of or visual senses since auditory birth-having never had a particular experience—can never experience the respective sensation in dream. That is, congenitally deaf persons never have auditory imagery in their dreams, and similarly, congenitally blind persons are devoid of visual imagery in their dreams. However, if blindness occurs after the

critical stage of visual experience, i.e., after first 5 to 7 years it does not result in loss of the capacity to experience visual images.

Materials for the dream story come from the stimuli at the very moment of dreaming-as also from the dreamer's past experiences and his interests and urges. The experiences of remote past are sometimes reactivated. That the role of experience is important, is proved by the fact that very young children, having heard of fairies' tales, are more likely to dream of wizards and fairies. Besides, wish is also very important. Hungary persons dream of food, prisoners of freedom and homesick soldiers of their families. Desires, worries and tensions have a direct bearing on the contents experienced in dream.

Language of dream is more pictorial than linguistic, which means that verbal images do not occur frequently in dreams. Obviously, critical analysis or reasoning is not likely to take place in dreams.

Z.1

garden where a brass band is playing. He dreams that it is a festive day in May and that he is on an outing in the country. A brass band is playing and happy faces are around him. If one compares the dream and reality, it would appear that there is nothing in common between them. A man lying asleep in bed at home dreams of a gay outing in the country. However, one cannot ignore the fact that he sees his dream at the very time he can hear the music of a brass band, and that such music also figures in his dream. It is obvious that the stimulation caused by the music is percepted by the sleeper and transmitted to his brain where it evokes a series of images and ideas associated with this sound stimulus.

The German scientist G. Hilde-

brandt graphically describes hi three dreams all associated with the sound of an alarm-clock. The one and the same external stimulus, th alarm clock, sounded like a church bell in his first dream, like sleigh bells in his second dream, and like 'breaking dishes' in the third dream Another characteristic detail is that external stimuli delivered to the brain during dreams become distor ted not only qualitatively, but also quantitatively; at times weak stimul evoke very strong sensations. I a dream a person hears deafening gun-shots, when he wakes up h finds that the source of his dream was only the low puffing of a boiling kettle in an adjacent room. A times, the sleeper dreams that h has been stabbed in the heart by sword but the cause of the dream as only the bite of a mosquito.

Another source may be the stiuli originating inside the body of e sleeper. Their causes are diverse: n uncomfortable position of the ody, full intestines, distended rinary bladder, strained heart actiity or difficulty in breathing. rof. L. Rokhlin, the well-known ussian scientist, cites in his book leep Hypnosis Dreams instances nightmare accompanied by fear f death was observed in cases here the activity of the heart uring sleep was strained for one r the other reason. In case where ne sleeper's breathing was laboured, e dreamt that he was being choked r that he was drowning. Scientists ave repeatedly attempted to estaish the connection between dreams nd various external and internal timuli by means of special tests n spleeping subjects. The French vestigator Alfred Maury describes uch experiments that were perforned on him by his request. An pen bottle of perfume put to his ose made him dream of a perfuner's shop at Cairo, a city of the astern lands, he had recently isited. When a red light was hed on his face, the sleeping Maury reamt of storm, thunder and ghtning.

Very often, people have dreams hat reflect their every-day occupaion and the emotions associated vith it. Dreams often express trong emotions, innermost conlicts, unsatisfied urges, apprehenions and other feelings that nove man.

Preams in blind and deaf

It is generally held that dreams ring us nothing essentially new, nd that there is nothing in them hat the individual had not experienced or thought of in the past. his has been so vividly confirmed y the dreams of people in whom he perception of some sense organ as been absent since birth, such as

PERIODS SLEEP AND DREAM AT DIFFERENT AGES AFTER JOVANOVIC (1973)

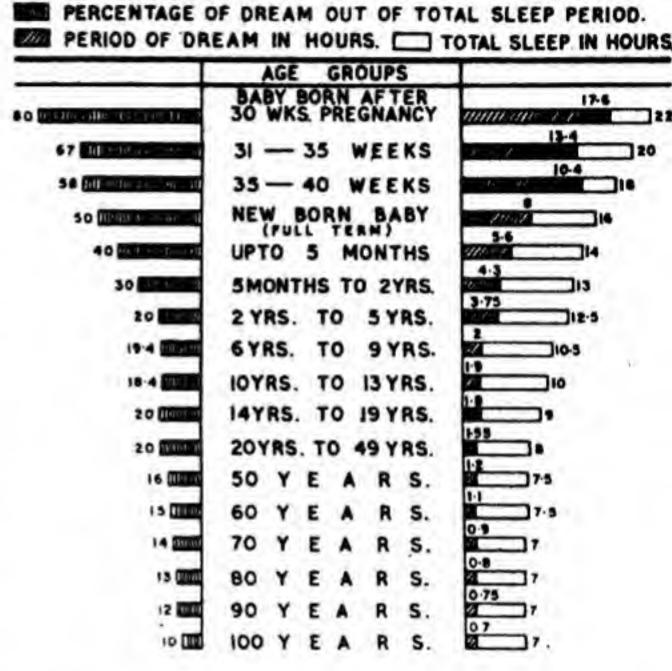


Fig. 3. Progressive reduction in dream phases with increase in age

the blind or the deaf. Investigations of this type, particularly the dreams of the blind, were carried out by the Russian psychologist K. Gringyova. She established that people who have been completely blind from the day they were born have no visual images in their dreams. A man of forty, blind since birth, told her that the river and trees in his dreams were connected with sounds and odours only. In his dreams he recognised people by their voices and defined the shape of objects by touch.

It should not, however, be assumed that in every single case the dream has some definite source. Often dreams are of a very complex nature. They are due to a combi-

nation of external and intern stimuli and are influenced by ex perience of diverse character an remoteness.

The famous Viennese neurologist Siegmund Freud, offers yet anothe explanation for dreams. Freud' first proposition is that dreams alway reflect hidden, unrealised, thwarte desires and feelings. Freud com pletely reduces all these huma feelings and desires to sexus feelings and desires, to their source and inhibitions that often go bac to the earliest periods of childhood The importance of the sexual in tincts in human life is not to b denied. It is, however, wrong t ignore, as Freud does, the wealt and diversity of human emotion



g. 4 Dream sequence to exemplify that dream is the guardian of sleep. The maid dreams that she is carrying her child for urination (Top left). The child is passing urine (Top right), as the waking stimulus increases in intensity, she dreams that a river is coming up (2nd row left), a boat appears (2nd row right), the boat enlarges (3rd row left), a boat with sail comes up (3rd row right) a steam ship makes its appearance (4th row left) and finally the maid wakes up to find that the child has already passed urine in bed (4th row right)

which cannot be reduced to exual feelings and desires alone. Oreams, as is commonly observed, an reflect many sides of an indiviual's personality, his interests, appriences, his store of knowledge, the order and nature of his emotions.

Causes and mechanism of dream: recent advances

A new 'objective method' for investigating sleep and dream mechanisms was discovered by the German psychiatrist Hans Berger (1929). He demonstrated that Towards better understanding

REAMS have always intrigue man. Before 1950s an exper menter had no way of knowing whether his subject was dreaming not. However, by early 1950s cons derable improvement in this fie was made. Eugene Aserinsky-or of the students of Nathaniel Klei man, an authority in psychophysi logy of sleep and a professor Chicago—was observing eye mov ments of sleeping infants and sleepi adults. He had arrangement for electrical recording of eye movement in adults. He discovered that dream ing is signalised by a rapid eye mov ment(REM), as opposed to dreamle period with non-rapid eye moveme (NREM). He also recorded hea beats, breathing rate and brain way pattern as indicated by the electro encephalogram (EEG). As EEG of sleeping individual differs from the of a waking one, EEG also diffe from one another during REM ar NREM periods. This difference wi not clearly established before as other Kleitman's student, Willia C. Dement, showed that dream characterized by a distinct physic logical state with more rapid breat ing, heart rate and eye movemen along with a change in EEG. The EEG and REM are particular important in dreams.

electrical potential changes could be detected by electrodes place on the outside of human sku (electro-encephalogram, EEG). These changes are very small (in the region of 50 microvolt). In the normal waking state the potential are integrated into regular waves of two frequency ranges; from 8 to 15 per second (alpha rhythm, also known as Berger rhythm) and 10 to 25 per second (beta rhythm). These wave forms are established at adolescence. With sleep these

Z.

voltage) of individual waves increaes. Sleep itself can no longer be egarded as a single state. Recent avestigations by T. Desiraju of he Department of Physiology, All ndia Institute of Medical Sciences, New Delhi, have confirmed that the information communication in sleeping brain is in many ways listinct from that of a waking tate". Orindary sleep, in which he subject makes no eye or limb novements and exhibits high ampliude slow EEG waves, is interruped several times in the night by that is termed as the 'paradoxical leep' lasting for a few minutes (Fig.). During this phase the subject hows rapid eye movement (REM leep) and rapid, low-voltage, nonmiform EEG activity is observed. But, judged by the intensity of stinuli necessary to wake him up, he subject is more deeply asleep luring "paradoxical sleep" than luring ordinary sleep (according to A. Jouvet of the Department of Experimental Medicine, Lyon, rance). Since this stage of sleep esembles neither normal nor wakeul state, it has been given the name paradoxical sleep". The Ameican neurophysiologists E. Aserinky and Nathaniel Kleitman (1955) tudied the movements of the eyes uring sleep by recording the elecro-occulogram. They found that he paradoxical sleep (or fast rave sleep of EEG) was invariably ssociated with rapid eye movement REM). Human beings aroused at time when they showed low voltage, ast wave EEG activity and rapid ye movements generally reported hat they were dreaming. This barvation and other evidence idicate that rapid eye movement eep (REM) and dreaming are losely associated. Thus the paraoxical sleep is also known as fast-wave" sleep, activated sleep, spid eye movement (REM) sleep, eep sleep or 'dreaming' sleep.

otentials slow down and amplitude

From the rapid eye movements similar to one shown by human beings while dreaming, one can infer that the animals also dream. Some 40 different species of mammals have recently been systematically investigated by H.B. Van Twyver (1974) of the Department of Psychology, Florida Technical University (U.S.A.). The 'paradoxical alcep' was observed in all the mammals except the monotremes (egg-laying mammals commonly found in Australia). Van Twyver (1974) concluded that the paradoxical sleep (associated with dreaming) was of recent origin and coincided with viviparity (the ability to give birth to living young). Thus those mammals which give birth to Irving young are capable of dreaming.

Information obtained from animal experiments has filled in many a gaps in our knowledge regarding the mechanisms of dream. Fluid obtained from the brain (CSFcerebrospinal fluid) has been shown by the Swiss physiologist Marcel Monnier (1968) to contain a substance with properties that induce sleep and increase rapid eye movement in alert animals. There is some evidence that mechanisms for the two alternating phases of sleep (rapid eye movement and non-rapid eye movement, 'slow wave sleep') lie in the brain-stem (Fig. 2) and are influenced by biogenic particularly 5-hydroxy tryptamine (serotonin) and epinephrine. The serotonin-containing nerve cells are located in the medial tegmentum (inner and more dorsal part) of the pons and lower mid-brain. They project upwards to the hypothalamus, thalamus and medial temporal cortex (concerned with the regulation of emotions and internal environment of the body). Destruction of serotonin-containing nerve cells results in insomnia (loss of sleep) with disappearance of both the phases of sleep. Inhibitors of the enzyme monoamine oxidase, on

the other hand, selectively diminis or abolish the rapid eye movemen sleep. Further, the dream compo nent of sleep can he selective inhibited by the destruction of no epinephrine-containing nerve cel in the locus coeruleus (a bluish are in the pons). It is likely that no epinephrine plays a pivotal ro in the causation of the 'paradoxica sleep'. This is, however, contro versial. The German physiologis Jovanovic' (1975) claim U.J. to have successfully abolished th paradoxical sleep (REM) by givin drugs which block the synthes of nor-epinephrine (alpha methy dopa). On the other hand, th Italian physiologists J. J. Segui and coworkers (1973) have pu forward the view that the rhythmi discharges of the medial vestibula nucleus of the pons (associated wit REM) are due to the activation of an acetylcholine-liberating mecha nism. A unified concept is project ted by the Swiss physiologist, Marce Monnier (of the Institute of Physio logy, University of Basel) that for normal sleep-wakefulness rhythr an interaction of activity of seroto nin, nor-epinephrine and acetyl choline should occur.

The structural basis of rapid ey movement sleep has recently been elucidated by the American neuro pathologist Raymond Adams (1974) This phase of normal sleep ha been traced to bursts of activity in the medial vestibular nucleus o the pons which is connected through the medial longitudinal fasciculu to the motor nerves supplying eye ball muscles (Fig. 2). Also M Jouvet of the Institute of Experi mental Medicine, Lyon (France has shown that the paradoxica sleep is imposed upon the cerebra cortex by the nuclei of th pons. Dreaming is a manifestation of the residual cortical activity in light sleep (as judged by EEG but deep sleep is determined by the strength of stimulus needed to wake up) and of a breakdown of critical reactivity. The fear or wish-fulfilment, according to Nathaniel Kleitman, the well-known American sleep physiologist, is also an indication of the inactivity of the nighest centres of frontal cortex.

Embryologically, at the foetal age of 28 weeks there is no evidence of wakefulness. In older, premature ind newborn babies sleep is broken by periodic awakenings (Fig. 3). There occurs a shortening of dream period from birth to old age. One hould, however, live for more than 00 years to reduce the dreaming eriod to zero per cent. This conorms to the "evolution theory" of ream put forward by Nathaniel leitman (1963). The sleep period ith rapid eye movement is longer in nimals lower in the scale of evoluon and also in the younger animals f a given species. Thus the dreaming ppears to be a biological compoent of sleep and that it is given a sychological meaning at a later age when the brain has had time to evelop functionally. One may also ike into account the dissociation "brain sleep" and "body sleep". n slow wave (dreamless) sleep, the rain (psyche) sleeps but the body nay be awake as is seen in sleepalkers. At times, in cases of freaming' sleep, the body sleeps but ne brain is awake. This occurs in ne course of nightmares. Thus here are many systems involved sleep-wakefulness-dream. ystem is responsible for the psychic omponent of the dream and the ther for the physiologic component.

ctivity of sex organs during sleep

There is a high incidence of erecon of penis during "rapid eye novement" sleep. Erection of penis

(according to phallographic investigations-recording of electrical potentials of penis-carried out by the German physiologist, U.J. Jovanovic) occurs 3 to 6 times in the night. The strength of erections (strong or weak) and their period vary. The phases of erection and dream occur more in the later part of the night (early morning hours) than in the midnight. In young adults, the total period of erection of penis has been found to be 100 to 110 minutes in a night and dreaming period 100 to 107 minutes. Earliest age at which erections of penis were recordable was 6 months. In men over 70 years, erections were still found but the total time period and strength of erection was reduced. bed-wetters Sleep-walkers and showed longer periods of erections. Similarly, erection of clitoris and contractions of vagina were recorded in females.

Functional significance of dream

Dreams often appear as guardian of sleep and integrate external stimuli to their own contents, according to Siegmund Freud. This protective function of dreams in defence of sleep is clear from Freud's observations. For example, the dream takes care that the awakening stimulus is so modified psychically that it loses its stimulating activity. Marcel Monnier (1969) cites a typical example of dream as a guardian of sleep given by O. Rank. The maid dreams of a call of a nature in the child (symbol of the waking stimulus); the call is satisfied and so she can go on sleeping. Strengthened by the waking stimunlus the content of the dream is often intensified. The waking stimulus wins and the maid

wakes up when it is too late (Fig. 4)
Recent trends in sleep physiolog (Dell, P. and J.J. Puizillout of Ma seille France, 1974, "Interference of baroreceptive and vagal afferent with sleep mechanisms, Proc. XXV International Congr. of Physio New Delhi, 10, 188-189) suggesthat the rapid eye movement slee (associated with dreams) service mainly maturation and organization

Is dreaming necessary to maintain bealth?

of brain functions.

If humans are awakened every time they show rapid eye move ment, they become somewhat irritable and anxious. If they are then permitted to sleep without interruption, they show a great deal more than normal amount of paradoxica sleep (associated with dreams) for a few nights. The same 'rebound' effect is seen in animals treated the same way. These observations have led some investigators to conclude that dreaming is necessary to maintain mental health.

Further reading

- Aserinsky, E. and N. Kleitman (1955). Two types of ocular motility occurring during sleep, J. appl. Physiol., 8, 1-10.
- Freud, S. (1961), Die Traumdeutung. S. Fischer Verlag. Frankfurt.
- Ganong, W.F. (1973), Review of Medical Physiology, 6th ed., pp. 120-124, Lange Medical Publ., U.S.A.
- Glees, P. and Mahdi Hasan (1975), in Klinische Pathologie des Vegetativen Nervensystems, Eds. Sturm and Birkmayer, pp. 141-204, Gustav Fischer Verlag, Stuttgart (W. Germany).

We are the wholesale dealers in supplying quality genes of all makes . .", "We are the sest manufacturers of intellect genes. ."—so would run the future commercials on TV and n newspapers. There will be several 'genetic planning centres' all over the country and the senetic counsellors would be sought after for advice

THEMICAL engineering, electrical engineering, aeronautical ngineering civil engineering and ow hot from the oven is what called the genetic engineering nd technology. This is perhaps he finest output from the brains f biologists who have been nterested in tailoring and manipulaing heredity to the best of man's dvantage. In principle, genetic ngineering refers to the technique f adding, subtracting or replacing egments of hereditary material alled DNA which actually carries he genes. Genetic engineering, n short, is on the brink of revoluionizing the traditional concept of nan about God and creation. Some cientists claim that the only thing oo sacred to tamper with is scientiic investigation itself. Others, lowever, point to numerous instances n which technology has outrun nan's wisdom (nuclear stockpiles) nd they envisage that if research n genetic technology is not constraned by set guidelines, geneticists nay bring into being a dreary Huxcian nightmare.

The onset of this new revolutioary discipline of genetic engineerng took place at MIT, U.S.A. when Nobel Laureate Hargobind Chorana and his schoo! first reported total synthesis of an artiicial gene with the potential for unctioning inside a living cell. Although this was perhaps the simplst and smallest gene that could naturally be present in a living cell, et Khorana group's result represened a major step toward the day when piochemical cure of genetic defects can be a reality. Since then many erticles in the popular press have ended towards Promethean predic-



GENETIC ENGINEERING— TWO SIDES OF A COIN

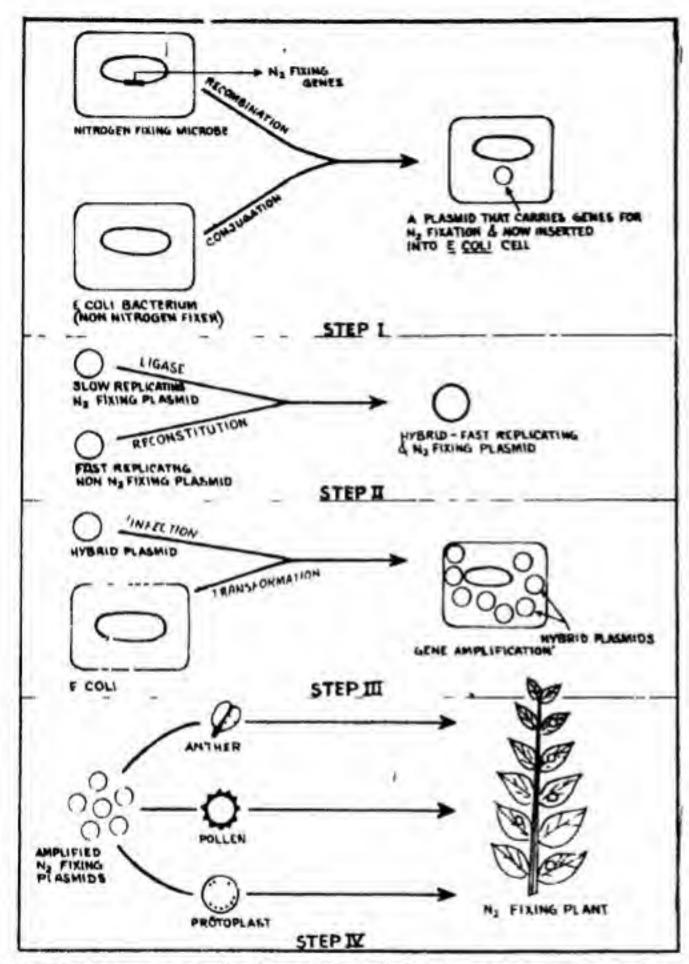
KESHAV TREHAN

tions of unlimited control and have led the public to expect the blueprints of human personalities. Most geneticists, however, have had more restrained second thoughts.

Correcting mistakes of the Creator

Currently there are more than 100 laboratories all over the world involved in perfecting techniques in genetic engineering and recombining DNA from several sources to construct hybrid molecules of heredity. The concern stems from a recently developed technique for joining unlike pieces of DNA into biologically functional molecules that can

be introduced into research work horse-the bacterium Escherichia col The technique employs extrachromo somal rings of DNA, called plasmid which are extracted from bacteria cells, snipped into linear pieces an spliced with foreign DNA fragment to form new hybrid molecule These artificially constructed plasmic can then be reinserted into bacteri where they again replicate at a rapi rate expressing genetic informatio from both parent DNA molecule This exciting new method has bee developed by Stanley N. Cohe and his research assistant, Anni C.Y. Chang, of the Department of



regionering the genes to obtain nitrogen fixing varieties of crop plants: 1. Preparation of fact acterial cells with plasmids carrying genes for nitrogen fixation. 2. Preparation of fact epilicating nitrogen fixing plasmids. This can be facilitated by an enzyme called ligans which can join two pieces of genes together. Thus a hybrid molecule is formed. 3. Gene applification for nitrogen fixation. The hybrid plasmid molecule can "infect" and transfer bacterium E. coli, and multiply as an independent unit in the bacterium. Up to fifty per ent of total number of bacterial genes may be nitrogen fixing. 4. Incorporation of nitrogen xing genes into wheat, rice etc. Whole authors, pollen grains and plant cell protophasts ay take up and harbour the concentrated fast replicating nitrogen fixing plasmid, and ants can be raised from these using tissue culture techniques.

Medicine, Stanford University, in collaboration with microbiologists. Further experiments by the above roup demonstrated that animal DNA, from South African toad, ould be linked with plasmid DNA to orm recombinant molecules which eplace stably in the bacteria and appress the ability to synthesize

a particular nucleic acid coding for enzymes. Two more researchers at Stanford University, California, Janet E. Mertz and Ronald W. Davis, have discovered a restriction enzyme which cleaves DNA or hereditary material in a very special way creating "sticky ends" which facilitate joining of two species of

DNA into hybrid molecule. The discoveries have greatly facilitate the research on forming hybrid hereditary molecules. One can foresee that the benefits of recombining DNA could lead to advances it medicine and to a large extent it agriculture. It seems to be offering possible breakthrough in basic research as well as practical applications.

The most important practice applications include the construction of bacterial cells as "factories" for synthesizing medically valuable biological substances such as insulir pituitary growth hormones, huma antibodies, human interferon o viral proteins for vaccine production Professor Joshua Laderberg, Nobe Laureate in medicine and physiolog at Stanford University, writes "Thi is the directive, in my own view that will lead to a technology of untold importance in diagnosti and therapeutic medicine, the read production of an unlimited variet of human proteins". Anothe application is the eventual gen transplantation to help cure humas hereditary diseases. Much experi mental work is underway to correct which caus genetic disorders diseases.

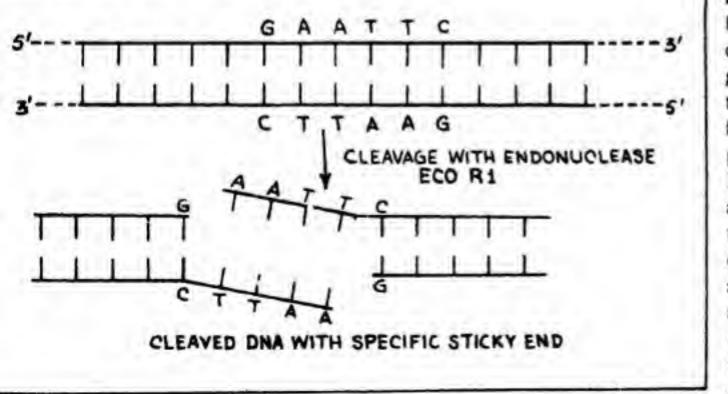
common example 0 genetic disease in human beings i diabetes. Many patients are kep by repeated injections o the hormone insulin. While i keeps them alive, the injection o insulin is not the full equivalent of the normal physiological function Such diabetics are known to be more susceptible to disease, to heart and circulatory problems, etc. Normally the synthesis of insulin takes place only in beta cells in the islands of Langerhans in the human pancreas. In the diabetics these cells fail to produce an adequate amount of insulin Since the full DNA content of genome is present in every cell, the senetic instructions specifying the sequence of insulin are probably present in all

Restriction endouncleases

THE science of genetic engineering is the outcome of some najor developments in DNA technoogy. The major advances are: liscovery of means for cleavage of ONA at specific sites, development of methods for joining of DNA nolecule and discovery of techniques or the introduction of DNA into therwise resistant organisms. Now he enzymes are known which proect the host cell against the invaion of foreign genetic material. These enzymes, known as restriction ndonucleases, break up the DNA eproducibly at a limited number of ites by recogning specific tracts of DNA ranging for 4 to 8 nucleotides n length As cleavage is the result of in enzyme and the suceptible sites in DNA molecule, the number of cleavage depends upon both the particular enzyme and the particular DNA. In some instances there is only one such tract and DNA molecules split at only one place, whereas in some cases DNA can be severed at 13 sites by using different restriction enzymes. The restriction enzymes cut both strands of DNA molecule, and the break may be at the same base pair or staggered by several bases as shown below.

The segments of DNA thus separated have sticky ends, or can be made sticky with chemical treatment, and joined together in an arbitrary manner. In one instance, the ribosomal RNA genes of African clawed toad have been introduced into Escherichia coli where they were propagated for 100 cell generations. In future it may be possible to transmit genes into bacteria from human beings for the production of insulin on a commercial scale. Industrial production of other chemicals and drugs can also be envisaged.

7.1.



the beta cells of the islands of the Langerhans. Evidently, these instructions present in other cells are not in use. One approach to the problem of diabetes would be to attempt to turn on the synthesis of insulin in another set of cells. One can supply to a group of these cells a wholly

new gene or set of genes which would code for the synthesis of insulin and which might not be subject to the normal repression. In order to do it, one has to take the help of microbial genetic models. In bacteria, a variety of means exist to provide exchange and increments of genetic material. One interesting way is

through the agency of viruses and another is transformation which is uptake of genetic material directly by the cells. In the case of pathogenic viruses that kill cells, the virus information is ultimately lost to the host. However, many viruses are simply "passengers" and do no detectable harm to the cells they infect. These viruses can carry genetic instructions from one cell and transfer or transduce into another cell. These transduced pieces of genetic information then become the permanent property of the recipient cell and information in this piece of gene is utilized by the cell for its own advantage. Two such viruses known to have infected man are SV 40 and Shope papilloma virus. In several cases there is every reason to suppose that viral genetic information becomes a relatively permanen operational part of the genetic information of the infected cell At this point technically and literally the stage is set. If one could obtain a virus similar to SV 40, able to pursue within human cells and carry an expressible gene for insulin in lieu of a normal viral gene, one could indeed be able to provide a genetic alternative to the daily injections of insulin. Not in the distan future, one could also synthesize a polynucleotide chain (which make DNA) capable of coding for insulir and for other genes necessary to in tegrate the DNA into a chromosome or maintain it as a plasmid. The art of polynucleotide synthesis ha already been perfected by Professo H. Khorana and such a synthesi need only be done once becaus when the DNA is available, natur provides the means to copy it wit the highest fidelity. The manufactu red and/or inserted segments ma be permanently associated wit cells and supply the genetic informa tion required to produce the missin enzyme or protein. At presen there are difficulties in establishin

the permanent association of th

DNA segment with the cell. Once the permanent association with the host cell is accomplished, any gene can be "engineered". People desirous, before they are conceived, could have exact characteristics desired by them in their child. Not only colour of hair and eyes, sex, height and built but also whether one wants one head or two, one large brain or several small brains could be engineered. Besides, genetic engineering by surgery of "sick" genes is not very remote, and repairing, replacing or suppressing a sick gene can be envisaged.

Proxy mothers

One interesting potential which genetic surgery or engineering can attribute to humanity is that of possibility of separating "genetic motherhood" from "gestational motherhood". Women have been both he "genetic mothers" contributing heir genes and chromosomes and 'gestational mother" contributing nourishment to the fetus. Reports claiming transplantation of an mbryo from one woman's womb o another have been published. Once an egg (fertilized ovum) can be successfully implanted in the womb, he way is open for "proxy mothers". This would perhaps be of great dvantage to people who are issueless or any hereditary reason. Technology could go one step further and imply eliminate the process oregnancy and child birth altogether. There are a few reports from Camoridge, England, of in vitro fertiliation of human ovum. A human mbryo could also be removed from he uterus and placed in an artificial vomb, that is, a womb contrived by nan's technology. Such ex-utero estation may have some obvious dvantages. But, a word of caution! t does not imply in any way that one an dispense with family. In this ighly impersonal world, the family the only institution where each erson is sought after and loved for

what he is and not for what he does. Destruction of family would perhaps be the most cruel act.

Out of wedlock

One idea which can be traced back to genetics of micro-organisms is that of "cloning" the human cell. In principle, the nucleus of a living cell is induced to cleave and propagate a whole organism genetically identical with the one from which it was taken. Cloning is a procedure to obtain a blueprint or replica of the original cell or organism. This has been achieved with plant and animal cells, in tadpoles of frogs, in certain species of flies and in carrots. Cloning of humans may be taken as a possibility only in remote future since no successful cloned human cell has been achieved. In a way, cloning will be more drastic in manipulating traditional methods of bringing new humans into this world. It will be entirely asexual and both ovum sperm would be unnecessary. There will practically be no need for genetical intercourse and pregnancy.

Green revolution

In the realm of agriculture there seems to be a real and beneficial contribution of genetic engineering. There are several areas in agriculture in which knowledge of genetic engineering can be successfully employed. The most important being: (i) introduction of genes for nitrogen fixation into nonleguminous crop plants, namely, wheat or rice, (ii) incorporation of genes suitable for the dryland farming, and (iii) incorporation of genes for withstanding high salinity particularly in saline soils.

Although plant breeders would still like to make an effort in this direction, the process is lengthy and there are several barriers, particularly of incompatibility. But there are several bacteria and blue green algae which have the genetic potential to grow successfully in dry and desert areas as well as in habitats with high salinity. It might be possible some day, when the technology is fairly standardized, to incorporate or transfer the genes for characters from these microbes to crop plants and use the vast waste land areas for agricultural purposes. In future such techniques may have profound effect on the possibilities of increasing nutritional value of foods at time when it may be critical for the survival of mankind.

Too close to perfection—a perfection perfecti

Genetic engineering presents quit different problems in man and i bacteria. With bacteria the more issues are simple. However, wit man moral issues really caus concern. One possibility of geneti engineering that raises serious mora question is the creation of clones carbon copies of human being already in existence. Normally, child is unique because he o she inherits the characteristics from both the mother and the father The possibilities of human cloning are enough to startle even a science fiction writer. Societies would be tempted to clone their best scientists soldiers and statesman. This would ensure a dictator to extend his power beyond the grave.

Fear has also been expressed that the escape or organisms containing novel hybrid DNA might inadver tently cause the spread of infectiou disease, carcinogenic or toxic agent or it might extend the range of ant biotic resistance. The potentia danger to human health stems from the fact that E. coli is primarily use as a host for recombinant DNA mole cules. Certain strains of E. coli ar already common inhabitants of th human intestinal tract, so no on can estimate the consequences i experimental strains of E. coli con taining new DNA combinations were to escape, infect research workers and

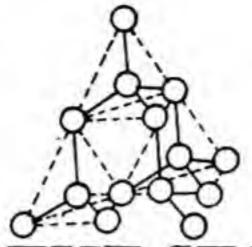
(Continued on page 379

THE story of crystallography is full of excitement. Elucidation of the structure of sodium chloride by it Lawrence Bragg in 1914 and of NA by Watson, Crick and Wilkins in 1952 by X-ray methods are the major milestones in this field. The rest eventr evolutionized chemistry, while the second provided a new ision to look into the mysteries of life.

Crystallography is the science of rystals, and so we must ask: What a crystal? Crystal is an unusual ate of matter. Its form and beauty ave attracted the attention of man nee early times. In middle ages rystals were prized for beauty as reil as magical powers they were elieved to possess. The word crystal' comes from the Greek word crustallos' used to describe transarent crystal of quartz which was elieved to be water frozen by intense old.

The concept of a lattice is ecessary in properly understanding crystal. A lattice is a parallel netke arrangement of points in three imensions as a result of repetition y three noncoplanar translations. crystal structure is formed by ssociating, with every lattice point unit assembly or basis of atoms lentical in composition (Fig. 1). If ne entire lattice is shifted by a istance a or b as shown in Fig. 1, ne lattice remains undisturbed. In ther words the lattice has a symmetry f translation. This is the basic haracteristic of crystals. Besides he translation symmetry, a crystal an possess axes of symmetry like wo fold, threefold, fourfold and ixfold, plane of symmetry or mirror nd a centre of symmetry or various ermissible combinations of these ymmetries (Fig. 2). We can define n axis of symmetry as a line such hat after rotation about it through 60°/n, the crystal assumes a conruent position. The value of n etermines the degree of the axis.

Crystals have been divided into



THE STORY OF CRYSTALLOGRAPHY

G. D. NIGAM

The history of crystallography is the story of development of the concept of space groups as assessed from the microscopic observation crystals

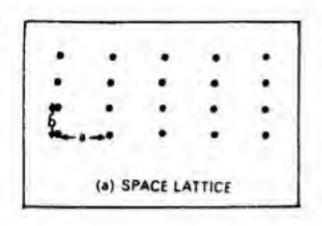
seven major systems on the basis of symmetry consideration. Each of these systems is further subdivided into a number of symmetry groups, the crystal classes or point groups, all possessing in common the characteristic symmetry of the system. The symmetry of a crystal is specified completely when its space group is known. A space group is a set of symmetry operations which make a pattern repeat in three dimensions. There are in all 32 crystal classes.

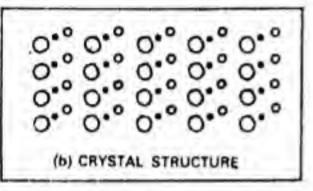
A crystal, as we see it, is a solid bounded by naturally formed plane faces. The planes are an outward manifestations of the internal arrangement of atoms and molecules in a crystal. Further, a crystal is not an exact scale model of another crystal of the same substance, and so the outer symmetry is sometimes misleading. Before the discovery of X-rays it was difficult for an observer to sketch the inne symmetry of the crystal structure.

Classical crystallography

The first step to show underlying symmetry of all crystals of a give substance was taken not until 1669 when Nicolaus Steno of Denmar published De Solido Intra Solius Naturalitre Contents. In this work he made an observation based of his study that the angles between the corresponding faces of crystal are same in case of quart it is known as the law of constancy of angles. Steno's work was the first attempt to discover an order in the variety of crystal shapes.

A remarkable observation was made in 1774 by Abbe Huy (French Huy observed that if a calcite to continuously cleaved, one arrives a





ig. 1. A two-dimensional space lattice and a crystal structure

final rhomboid nucleus or molecule ntegrante by the repetition of which he whole crystal is built up. Fig. 3 is he reproduction of one of his figures which illustrate the construction of he 'dog-tooth' habit of calcite from hombohedral units. Further, he ound that there were three directions n the crystal along which he could reak it and get a bright plane surface the the first one. Such a plane in the rystal is called a cleavage plane. He noted that the angular relation between the cleavage faces was the ame in every fragment, and so he rrived at his concept of molecule ntegrante. Huy also propounded the undamental law of crystallography, namely, the law of rational indices. according to this law, the intercepts f a face of a crystal on three suitable hosen axes are rational functions of heir axial lengths.

Christian Huygen (Dutch) and tobert Hooke (English), at almost he same time in 1665, imagined a rystal to be a stack of spherical articles packed closely together in regular way. Franz E. Neumann and Carl F. Neumann (both Germans) went far in deducing the

symmetry properties inherent in crystals of a given substance, and classified the crystals into seven systems.

J.F.C. Hessel (German) showed in 1830 that crystals possess only 32 possible symmetries. Later these were recognised as point group symmetries—the group of symmetry elements which make the crystal indistinguishable about a point.

Crystallography progressed heretofore in a somewhat empirical manner. In 1842, Moritz L. Frankenhein and Auguste Bravais, both of French origin, conceived a theory which explained the crystal systems and their subdivisions on the basis of a space lattice. A primitive definition of space lattice has been given before. Frankenhein's contribution was to add that there are other ways of arranging points with identical environment in parallel orientation so that the whole array displays the symmetry of that system. For example, if we start with a unit cube which has a lattice point at the intersection of body diagonals as well as at the corners, we get by translation a new type of cubic space lattice which possesses all the characteristic of the cubic system. In 1842, Frankkenhein concluded that there are 15 types of space lattices. Four years

later, Bravais showed that as two of them were identical and so there 14 types of space lattices.

About fifty years later, E.S. Federov (Russian), A.M. Schoenflie (German) and W. Barlow (English independently gave a complet enumeration of 230 space group and 32 crystal classes (point groups). This development is the final step in abstracting the inner symmetry from the external forms and gross physical properties of crystals.

In the middle of the present centur there were further developments i the theory of symmetry through th work of Russian crystallographer A.V. Shubnikov and N.V. Belov Shubnikov introduced the operatio of antisymmetry into space grou theory. The basic idea is that i addition to the three ordinary space variables x, y, z, which were consider ed in the theory of space groups one may consider a fourth variable say S, which can take one of th two values, such as + or -, black o white, magnetic moment parallel o antiparallel to a given direction The new theory showed that there are 36 Bravais lattices and 1651 Shubni kov space groups. These develop ments proved invaluable in describin the structure and properties of ferro

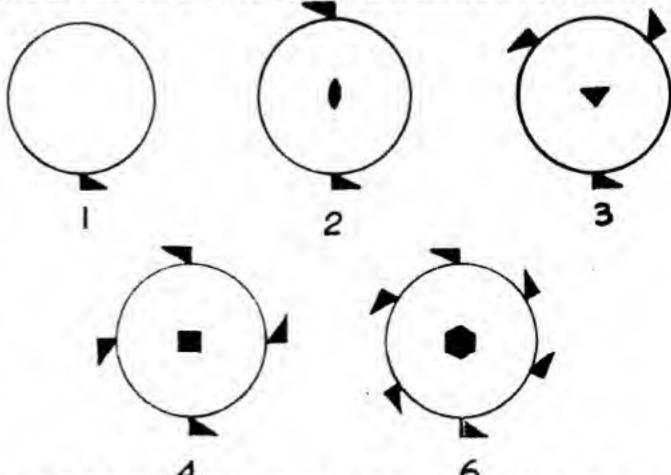
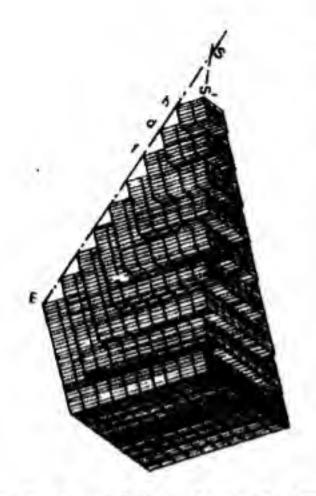


Fig. 2. A triangle partern is generated by a single crystattographic rotation operation (1, 2, 3, 4, and 6 fold-axes of symmetry)



figures, showing dogtooth habit of a calcite crystal

magnetic and anti-ferromagnetic materials.

Modern crystallography

The era of modern crystallography begins from 1912 when Max von Laue (German) suggested his two assistants, Friedrich and Knipping, to try X-rays affect on a crystal. Laue argued that if X-rays were electromagnetic waves of wavelength 10cm and crystals were built up of three dimensional lattices of the same order of magnitude as the wavelength of X-rays, the X-rays would be diffracted. When X-rays fall on a crystal, they combine with each other in such a way that in some directions the scattered X-rays are reinforced and in other directions they annul each other. This phenomenon is called diffraction (Fig. 4.) The first trials bore no result. But when Knipping placed a photographic plate on the other side of the copper sulphate crystal, he obtained a photograph. It showed a pattern of difffracted spots which enabled him to determine the atomic arrangement inside the crystal. A new branch of science was thus opened. Later in 1914, Professor Max von Laue was honcured with a Nobel Prize in physics for this famous experiment.

Laue carried similar experiments on the crystal of zinc blende. Directing the incident beam along three-fold axis of the crystal, the arrangement of diffracted spots on the photograph also showed a three-fold symmetry (Fig. 4). Paul Niggli (German) in 1919 showed that the space group of crystals could be determined from X-ray diffraction photograph.

The scene of the drama shifted from Germany to England when Professor W. H. Bragg of the University of Leeds did some pioneering work in X-ray spectra with his famous X-ray spectrometer. He was naturally interested in Lauc's results and so discussed them with his son, Lawrence (Sir Lawrence Bragg) who was then a research student at J. J. Thomson's laboratory, Cambridge. The younger Bragg thought seriously over Laue's paper and explained the results in a much more simple manner. He imagined the crystal as consisting of a set of planes. The diffraction of X-rays, according to him, was equivalent to reflection from these planes (Fig. 5). His celebrated equation is

2 d Sin θ = n λ where d is the spacing of the structure, & the glancing angle, A the wavelength of X-rays, and n is an integer. This equation came to be known as Bragg's Law. To illustrate the principles of X-ray structure analysis, let us consider the structure of KCI which was examined by Bragg himsell. He used an arrangement like an ordinary spectrometer to measure the intensity of specular reflection from a cleavage face of a crystal and found six values of \$\theta\$ for which sharp peak in intensity occurred. He, then, used his equation to calculate the ratio of the (111) and (100) plane spacings, which turned out to be 1/43, showing that the ions must occupy a cubic lattice. Since in KCI half of the ions are positive and half negative, the structure in Fig. 6 is the only possibility. Braggs were able to set forth the structures of KCI, NaCI, KBr, KI, diamend, Zns, NaNO, and CaCO, In 1915, W.H. Bragg and W.L. Bragg were jointly awarded Nobel Prize in physics for their work on the structure of crystals.

But it was soon realised that even a slight complicated structure cannot be solved by trial and error method. Bragg again took the lead. He argued that since the crystal is a three-dimensional periodic arrangement of atoms, it can be represented by a Fourier series in three dimensions. He showed that the coefficients of the Fourier series are the diffracted amplitudes of the X-rays wavelets. If the series were summed, it would give a representation of the electron density within each unit cell. The atoms would be the peaks in the electron density function, and so the structure could be solved. Unfortunately the structure amplitude is not just a positive number but, in general, is a complex number having both magnitude and phase. The magnitude can be measured (from the intensity of the reflection), but there is no experimental way of observing the phase constitutes the This deficiency "phase problem" of X-ray crysta llography.

In time, crystallographers evolved indirect methods of guessing phases

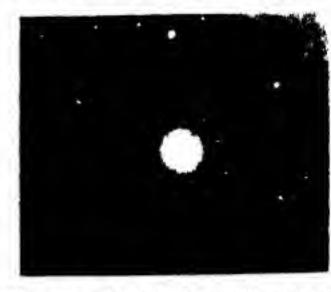


Fig. 4. A Laues' photograph of silico crystal with a (111) face normal t the X-rays

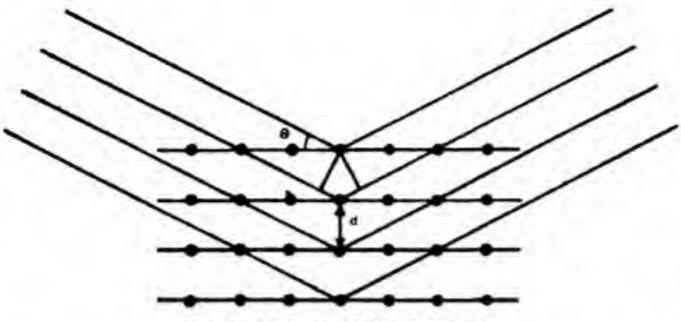


Fig. 5. Derivation of Bragg's equation

rom X-ray diffraction data of the crystal. Theory of X-ray diffracion by perfect and imperfect crystals was given in 1914 by an Englishman, C.G. Darwin. Laue first gave the cinematic theory of X-ray diffracion. Later Laue and P. P. Ewald ooth independently gave a dynamical neory of X-ray diffraction. Much progress was also attained in intrumentation side. Debye-Scherrer amera, Weissenberg camera, 4ircle single crystal diffractometer re but a few examples. Several esearch schools soon emerged all semming from Braggs, and the

knowledge of crystal structures steadily increased.

Experiments were performed to establish the wavelike properties of electron and neutron beams around 1930. When a beam of electrons or slow neutrons was allowed to fall on a crystal, it exhibited diffraction phenomenon. Electron diffraction was used to study the structure of surface atoms in solids or the structure of molecules in liquids and gases. Neutron diffraction has certain advantages over X-rays diffraction. Unlike X-rays, neutrons are scattered by the nucleus

Fig. 6. The structure of KCI crystal as seen by X-rays

K'
CIO

of an atom rather than by its electrons. Besides, neutrons posse its own magnetic field. As a result neutron diffraction is a powerfut tool in locating hydrogen atoms it substances such as ice or organ compounds of biological importance. It also enables scientists it study the nature of magnetic field in ferromagnetic materials like iron In other words, neutron diffraction provides information about magnetic structure of crystals.

Crystallography in India

In India, the development of crystallography and crystal physic owes much to the efforts of the la Prof. C.V. Raman. In 1923, he an K. B. Ramanathan were the first t give a theory of X-ray diffractio from liquids, which initiated expermental work on the structure of liquids and amorphous solids b P. J. W. Debye and others. Prof S. Bhagvantam applied group theor to study crystal properties. Prof K. S. Krishnan investigated man structure-dependent properties o crystals. Prof. G. N. Ramachan dran, the foremost among crysta llographers, established triple helica structure for collagen, a protein which is found in animal skin Prof. S. Chandrashekhar first began the study of interesting propertie of liquid crystals-a state of matte which is intermediate between crys talline solids and amorphous liquids and made the subject popular in the country.

Prof. K. Banerjee was another pioneer in the field of crystallography. He studied crystallography under Prof. Bragg and, on his return, founded a school of research at Calcutta. He was among the few who tried crystal structure determination as early as in 1930. In 1933, he developed 'direct methods' which later proved powerful in solving the structures of complex crystals.

It was soon understood by many scientists in India and elsewhere that various types of defects like point defects, dislocations, etc., in crystals play a significant role in determining their properties. The presence of defects causes irregularities in the three dimensional periodic repetition of the contents of the unit cell in a crystal. Prof. A.R. Verma at Benaras University (now director, N.P.L., Delhi) took the lead. His researches on dislocation and polytypism are well known. Prof. G.B. Mitra established another group at I. I. T., Kharagpur, which is presently engaged in studying defects in metals and alloys. He is among the few in India who initiated Fourier methods and developed several techniques for estimating the nature and extent of different defects in crystals from X-ray diffraction.

Applications

The application of X-ray analysis imparted a new impetus to chemistry. The determination of NaCl crystal structure for the first time by W.L. Bragg showed that the prevailing molecular theory of ionic crystals was unsatisfactory. It confirmed that benzene ring is hexagonal and aliphatic chain has a zig-zag structure. Chemists were then able to see the molecule, measure the length of single, double and triple bonds, observe the distortion when they were overcrowded, see exactly the position of hydrogen bondsthe bonds which are responsible for so many unusual properties and of which little is known. The determination of the structure of vitamin B₁₈ by Prof. Dorothy Hodgkin and

her co-workers at Oxford by use of X-ray analysis is a landmark in the history of X-ray crystallograhy.

Crystallography influenced metallurgy too. It revealed that the structures of metals and alloys are not usually complicated. The techniques of X-ray analysis revealed the ways in which the atoms arrange themselves on alloying, and their rearrangement when they are heated.

The mineralogists should be thankful to crystallography. X-ray analysis made the chemistry of minerals and rocks clear, and the mineral world acquired order from chaos. The knowledge thus gained helped in understanding the distribution of elements in rocks.

Biology is another subject which was deeply influenced by the X-ray methods. It lead to the birth of fascinating science called 'Molecular biology'. Molecular biology deals with the structure and functions of the macromolecules like proteins, nucleic acids, viruses, etc. These materials have highly complicated structures containing thousands of atoms in one unit. The first X-ray diffraction photograph of a protein, single pepsin crystal, was taken by J. D. Bernal (English) in 1934. Many years later, J.C. Kendrew and M. F. Perutz working at Cavendish Laboratory, University of Cambridge, solved the structure of two globular proteins, namely, myoglobin and haemoglobin, confirming their helical structure.

Another landmark in molecular biology was the elucidation of the

double helical structure of deoxyribonucleic acid (DNA) by F.H. C. Crick, J.D. Watson and M. Wilkins in 1952, again at Cavendish Laboratory by X-ray analysis methods. Bragg hailed it as one of the major scientific events of the century. DNA is a genetic material which is responsible for transfering parental characteristics to the offspring. It carries all the information necessary to make nucleic acid as well as protein for the cell. Along these lines, molecular biologists are close to the mysteries of life. The computers and automatic diffraction equipment have played and are still playing a significant role in the advancement of molecular biology.

The history of crystallography clearly shows that scientific research is progressing towards a fusion of different sciences such as physics, chemistry and biology. There is a need that the experts of various fields should join together to probe deeper into the mysteries of nature.

Further reading.

- Bragg, W.L., The Crystalline State, Vol. I., Bell and Sons, Ltd., London, 1933.
- Bunn, C., Crystals: Their Role in Nature and in Science, Academic Press, 1964.
- Ewald P. P., Fifty Years of X-ray Diffraction, International Union of Crystallography, Utrecht, 1962.
- Phillips, F.C., An Introduction to Crystallography, Longmans Green Ltd., 1946.
- Watson, J.D., The Double Helix, Penguin Books, 1971.

K. BHATNAGAR





THE JOINTLESS RAILWAY TRACK

THE steam engine that puffs I out clouds of black smoke is n the way out. Many countries the West have already seen the ist of these engines: they are ept in the transport museums as eminders of the bygone age. In ndia, too, electrification and diedisation of a number of routes as already been completed. The eam engine has been replaced by ther electric or diesel locomotives. lowever, a large number of steam comotives still operate on other outes. It will take a few decades ore, before we in India would ly good-bye to the steam engine. The characteristic clackety-clack ound associated with railway travel

will also be a thing of the past in not too distant a future; thanks to the 'jointless' or 'welded' track. It has already been laid on more than 1200 kilometres (in different stretches) on some of the important routes. Progressive increase is planned in years to come.

The fish-plated track

Railway track consists of short rails, supported on and fastened to sleepers which, in turn, are supported on stone ballast. The standard length, in which rails are manufactured and supplied by the steel rolling mills, differ in different countries. In India, the length of rails varies from 10-13 metres; in some Railway travel is invariably associated with periodic clack kety-clack sound produced when wheels negotiate track joints and the puff puff emitted by the steam locomotive. It may however, not be long before both these sounds disappear from the scene

manufactured. These short rai are then jointed together wit fishplates and fish bolts, as shown i Fig. 1.

The main reasons for preferring rails in short lengths are: (i) difficulties in manufacturing very long lengths in rolling mills, (ii) difficulties in transport of rails of long length to far off destinations, and (iii) difficulties in taking care of expansion/contraction.

Perhaps, the most important factor in limiting the length of rails had been the technical requirement to provide for a gap between two successive rails, to take care of expansion/contraction. The join in rail forms a weak link in the entire track structure. The strengt of a fish plated joint is barely 55% of the parent rail; so a lot of deflection takes place at the joint. The result is that the joints run down far and cause damage to rail end. Considerable amount of noise

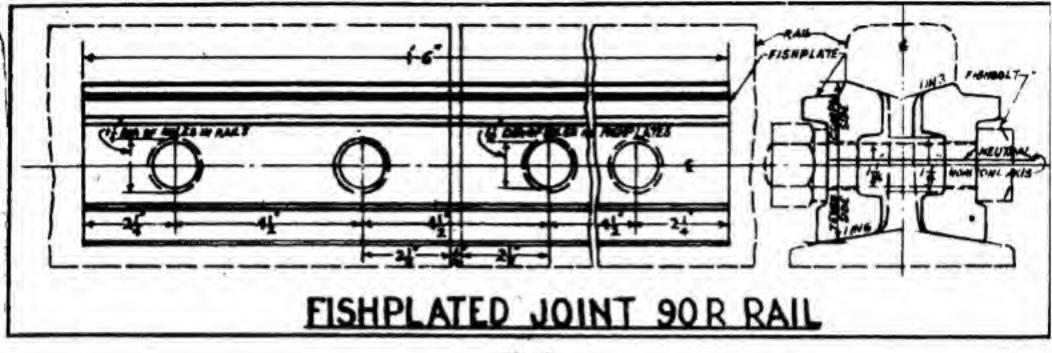


Fig. 1

enerated while the wheels negotiate be joints. The rail ends get 'hogged' ue to a permanent set developing a course of time. Due to high effections, the packing of the joint eepers gets disturbed and joints equire much more maintenance than he rest of the track. It is estimated nat the attention required by the points (in fish plated track) may be something the plated track of the total maintenance effort.

It is a matter of common knowledge nat the metals expand with increase temperature. Coefficient of linear xpansion of steel is 0.00001152 er degree centigrade. The range f atmospheric temperature, obtainig in the plains of Northern India of the order 0°C to 55°C. The ail temperature may be about 5°C 8°C higher than the ambient emperature on the higher side and °C to 3°C lesser on the lower side. o, the total maximum range of ail temperatures is of the order of °C to 65°C. In coastal areas, the ange is much less. For this range f variation in temperature, the xpansion/contraction in 13 m ail is of the order of 12 mm, free expansion were possible. lowever, as the rail is not compleely free to expand (being fastened n to the sleepers), the actual expanion is much less. The fish plated oint is designed for a maximum xpansion of 15 mm which has een found to be quite adequate to

meet the maximum expansion/contraction which may take place in 13 m rail. The joints just close during the hottest period of the year and open up about 10-15 mm during cold weather.

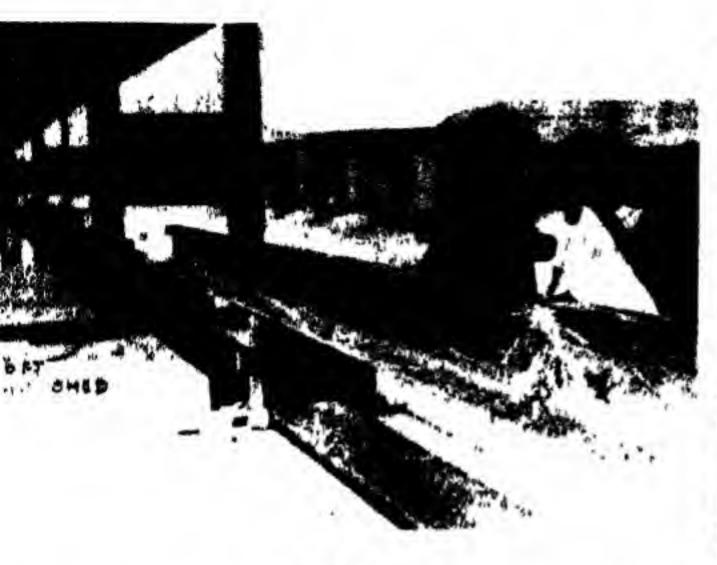
Elimination of joints

Elimination of the joints in the track had long been a dream of track engineers. However, all such attempts were thwarted as the technical problems associated with expansion/contraction of rails with temperature, could not be solved till after the World War II. It was necessary either to develop means for taking care of heavy expansion/contraction expected in long rails or to find ways and means for restraining the movement due to changes of temperature, safely.

During the World War II, there was a serious shortage of wooden sleepers in Europe. It was during this period that a lot of R & D effort was put in for development of concrete sleepers. With this came the elastic fastenings also. Once the heavy concrete sleepers and the double elastic fastenings came on the scene, solution of this twin problem became quite easy and within a short period a practical reality. It will be interesting to see how this was achieved.

Rails, even in normal track, do not expand or contract freely. As they are held to the sleepers by fastenings, there is frictional resistant to any movement of rails with changes in temperature. Even when the fastenings are somewhat loose frictional forces restrain the expansion of the rails. If, however, the fastenings are tight and exert sufficient 'toe load' on the rails, the relative movement between sleeper and the rails can be minimized of stopped. If such an assembly subjected to changes of temperature the rail sleeper assembly will have to move as a whole.

With the fastenings which wer in use earlier, it was not possible to exert sufficient and uniform 'to load' to restrain the relative move ment between the rails and sleeper all the time. But with the develop ment of elastic fastenings it becam possible to exert sufficient toe loa all the time more or less uniforml so as not to permit relative move ment between rails and the sleepers This, therefore, was the first ste towards making long welding of rails practicable. Once the relative movement between rails and sleeper is restrained, it would be of interes to visualize what would happe when the temperature rises or fall The rail tries to expand but as it not permitted to move because of its firm fixture with the sleeper rail-sleeper assembly start moving as a whole. This movemen is, however, resisted by the frictions resistance between the ballast an



Fle. 2

he sleepers Experience shows hat in a properly no intained track, the movement is possible only upto about 80 to 100 meters from he rail end Beyond 80 to 100 metry from the rail end, no move ment of the long welded panel takes place and the entire central ength remains completely stationiry, independent of any changes in emperature though the locked up tresses increase the temperature Near the ends of the long welded panels, switch expansion joints are provided These are capable of taking total movement of 120 mm This is well within what actually takes place n practice in a long welded panel It is obvious that the movement of rails which would have ordinarily aken place with rise in temperature s restrained more or less. So High hermal stresses develop in the track. even when the rails are fastened to the sleepers) at the mean temperaure (about 32°C to 33°C in Northern ndia where the total range of temerature is between 0°C to 65°C), the oal thermal force which comes into lay may be of the order of 55 tonnes the 52kg/per metre rails, used on

the Indian Railways. Compressive force (in summers) of such high magnitude can be potential source of danger in buckling of track. But, it has been possible to forestall such a situation by having a suitable type of track structure in which, apart from having a higher density of sleepers than what is used in the

single rail track, use is made of heavy types of sleepers, viz., concret or steel and of fastenings capable of guaranteeing adequate torsions rigidity. The requisite degree of lateral stability is further ensure by providing adequate boxing of ballast around sleepers.

Long and continuous welded track

Jointless track, in panels 0.4 to 0. km was laid initially by welding th rail ends. Suitably designed expan sion joints were provided betwee different panels to take care of th expected expansion. With the ex in-service perience gained with results, the lengths of welded panel has been increasing so much s that continuous welded rails ex tending between one station to the next without either a conven tional joint or any switch expansion joints, is a common practice now of most of the advanced railways, viz. Japan, West Germany, France, U.K. U.S.A. ctc

Long and continuous welded track has many advantages: first it permits high standards of riding comfort and journeys free from monotonous clackety-clack noise. Long or conti



Pg. 3

nous welded track also provides ibstantial economies in costs of ack maintenance, fuel consumption nd increase in service life of rails. s the track can be maintained to ery close tolerance, high speed train peration is made possible: speeds pto 210 kilometeres per bour are ready being obtained in some of e advanced countries of the world ke Japan.

On the Indian Railways also, long elding of rails has been accepted s a standard practice for all imporint sections where concrete or steel ough sleeper track with elastic istenings is planned. Already a otal of over 1200 km of LWR/CWR as been laid and this is likely increase progressively.

In India, the longest panel laid o far is about 10 km long; quite a w panels of 7-8 km length also xist.

Velding of rails

It will now be of interest to know ow rails are welded. Welding is one to join the two rail ends to liminate a potential joint. The electric-arc' and 'oxy-acetylene' velding -the two most common mehods of welding—are not found to o suitable for welding of rails beause of the peculiar shape and large ross-sectional area of rails. For velding of rails, a number of methods re in use. The most common are: i) Electric flash butt ii) Alumino-thermic welding, and iii) gas pressure welding.

Flash butt welding. Heat is generated when electric current reaction can be written as: outt welding of rails the resistance s provided by the small air gap

between two rail ends across which an electric arc is struck. This is achieved by bringing two rail ends which are to be welded close to each other and switching on a low voltage-high amperage current. When the rail ends are close to each other, an electric arc is generated. Fig. 2 shows the flashing operation in progress in an automatic flash butt welding machine. The rail ends are brought close and taken away in quick succession. In the process the rail ends become red hot. At appropriate stage the ends are pressed with a high butting pressure. The butting force used may be as much as 30 tonnes. Fig. 3 shows a joint so welded being ground by grinders. modern flash butt welding plants all the operations are done automatically and a joint can be welded in about 3 minutes. Very high quality of welds is possible with Flash Butt methods of welding. After welding in reasonable lengths in the welding plant, the welded rails are stacked. The welded rails are then loaded on a number of endless BFRs (special type of wagon) and transported to the site of work.

Alumino-thermic welding. This method of welding was perfected by Dr. H. Gold Schmidt of Germany around 1897 and has been used extensively for in situ welding (welding in the field). The technique is based on the exothermic reaction between aluminium and ferric oxide which is accompanied with considerable amount of heat.

basses across a resistance. In flash FeO₂ + 2A1 = 2 Fe + A1₂O₂ + 181

K. calories.

The reaction is completed with-

in 15-25 seconds after the mixture is ignited.

The theoretical temperature of reaction is 2960°C; but in actual practice only a temperature of 2450°C is achieved. At this temperature, the iron particles in the reaction are in a molten state. They settle down at the bottom of the crucible. This is poured into the joint kept ready for the purpose preheated to 950°C and with moulds fixed. Some alloying elements are also put in the 'Potion' so as to obtain steel of requisite characteristics.

Preheating of rail end is done either by burning petrol-air misture or oxygen-petrol mixture. It takes about 35 to 40 minutes for welding a joint when petrol-air mixture is used and about 15-16 minutes when petrol-oxygen mixture is used.

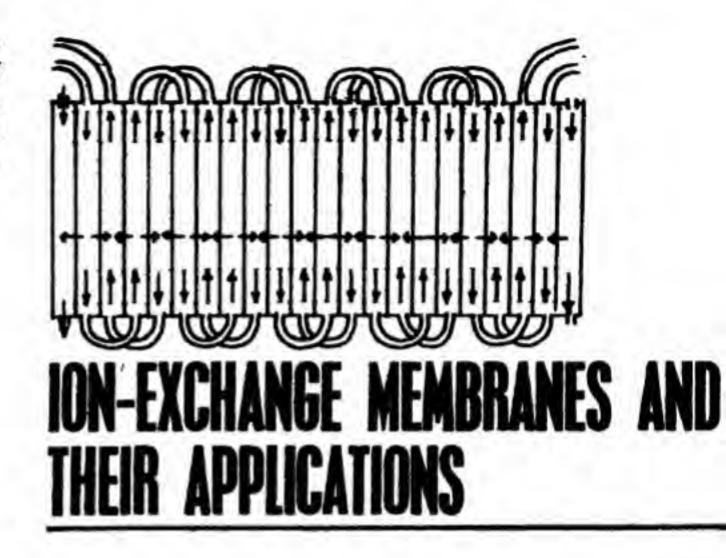
Gas pressure welding. This is a process where incoalesence is produced simultaneously over the entire area of the rail's butting surfaces by heating with gas flames, obtained from the combustion of gas with oxygen and by the application of pressure without the use of filler metal. The welds are characterised by a smooth surface and by the general absence of fixed metal in the weld zone.

On Indian Railways, only one plant of this type, imported from Japan, is in operation at Bande near Calcutta. The plant is mobile and the process is essentially a depoi welding process.

Further reading

- 1. IWR Manual, Ministry of Railways.
- 1. Mundrey, J.S., Track Modern ization, 2nd Edition, 1972.

on-exchange membranes have seen put to a large number of sees such as preparation, eparation, concentration and surification of chemical com-



THE term ion-exchange membrane is generally used for olid films, discs, foils, tubes, ribbons, dugs, etc. They can be used as a eparating wall between the soluions. The important characterisic of ion-exchange membranes, in ontrast with conventional semiermeable membranes, is that they re selective for one type of ions nly. A cation-exchange membrane eparating two solutions from each ther is permeable to cations only, while under a certain concentration n anion-exchange membrane is ermeable to only anions.

ypes and properties

lon-exchange membranes differ a structure depending on their methods of preparation. Two main types are known. For scientific surposes "homogeneous" membranes are preferred which are obserent unsupported gels. For ractical applications, reinforced or heterogeneous" membranes claim the advancage of higher mechanical

strength as they are supported by inert carriers or binders.

Most ion-exchange membranes are "mixtures", either homogeneous or heterogeneous, of an ion-exchange substance and an inert, more plastic resin. For instance, a mixture of linear polystyrene-sulphonic acid and a copolymer of vinyl chloride and acrylonitrile is dissolved in a common solvent. The solvent is evaporated so as to leave a thin homogeneous film of the two polymers. Homogeneous anion-exchange membranes can be prepared in a similar way.

Heterogeneous ion-exchange membranes are prepared by mixing finely ground ion-exchange resin of any type with an inert material such as polythylene. The mixture is shaped into a film of the desired thickness (0.1 mm-0.6 mm) by heat and pressure. The fraction of the ion-exchange resin in the mixture must be high enough so that it is possible for an ion to move from one surface of the membrane to the other, either by diffusion or by migration through many path in an electric field. On the other hand, too large a fraction of ion exchange resin in the mixture lead to a brittle membrane. Inorganization and invalidation techniques.

Membranes of excellent physical properties and chemical stabilities can be prepared. The films are fairly resistant to strong acid an alkali solutions and many commosolvents. They can be used upto 95°C. The membranes are generally stored under water to preventhem from drying out.

In addition to good mechanics resistance, membranes for technics requirements should also be sufficiently thin to have a low electrics resistance. They should be consistent composition and uniform thinness. Further, the membran should have a high ion-exchange

apacity because it is on this factor nat its selectivity mainly depends.

1embrane potential

The potential difference existing etween two solutions separated by n ion-exchange membrane is called he membrane potential, and can be easily measured by suitable lectrodes. If two solutions containing the same electrolyte AY in different concentrations are separated (Fig. 1), the membrane potential is summarised by the Donnan potentials between the resin and the colution on either side and by the diffusion potential as follows:

$$E = E_{\text{diff}} + E^{1}_{\text{DoB}} + E^{2}_{\text{DoB}}$$

$$= -\frac{RT}{nF} \left[\ln \frac{^{a}A^{2}}{^{a}A^{1}} - (n-z) \right]$$

$$\int_{1}^{z} v_{ry} \, d \ln ^{a}AY \dots (1)$$

dere R is the universal gas consant, T is the absolute temperature, is the charge number of the cation 4, Al and A2 are the activities of he cation A in the two solutions, AY is the activity of the electrolyte Y, z is the charge number of the nion Y, and very is the transport number of the anion Y in the resin. When the concentration of both olutions is much lower than the on concentration in the ion-exchange nembrane, the concentration of the eccompanying ions is negligible in the resin phase. Equation (1) can be imply written as :

$$E_{\mathbf{m}} = -\frac{RT}{nF} \cdot \ln \frac{A2}{A1} \cdot \dots \cdot (2)$$

Similarly, in the case of anion exchange membrane the membrane totential presuming ideal anion electivity is:

$$E_{\mathbf{m}} = -\frac{RT}{zF}$$
. In $\binom{aY2}{\overline{aY1}}$(3)

Sat. KCl

Known

KNO,

Applications of ion-exchange membranes

Fig. 2 depicts the simple apparatus for laboratory applications of ion-exchange membranes. The upper holes of the plexi-glass cylinders in Fig. 2(a) serve for inserting the electrodes and those in the bottom for emptying the cylinders. The apparatus shown in Fig. 2(b) is more advantageous for potential measurements and titrations.

Determination of ionic activity

The ionic activity of electrolyte solutions can be measured by means of ion-exchange membranes using the equations (2) and (3) given above. The measurements have special importance when the ions in question are such that a reversible electrode cannot be made at all (acetate, nitrate or fluoride ions), or if a suitable reversible electrode cannot be prepared in solution (alkali or alkaline carth ions). For example, the activity of potassium ions in an unknown potassium nitrate solution can be measured by the concentration cell shown at the bottom.

Ion-exchange membrane offers an opportunity for the direct determination of the total salt content of natural waters.

Electrodialysis

If an anode and cathode connected to an electric source are placed in two electrolyte solutions separated from each other by an ionexchange membrane, an almost unimpeded stream of counter ions begins through the ion-exchange membrane under the influence of the electric field. This process is called electrodialysis. The current is carried through the ion-exchange membrane chiefly by the counter ions and only partly by the accompanying ions.

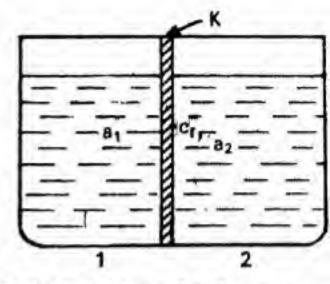
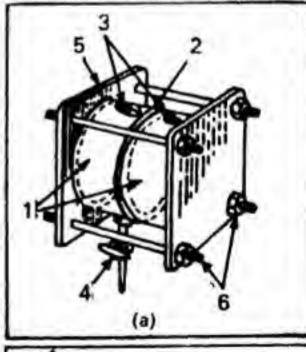


Fig. 1. Cell scheme for the purpose of studying the operation of an ion-exchang membrane (K - catiou-exchange membrane)

Electrodialysis carried out by means of an ion-exchange membrane is virtually selective for the counterions of the ion-exchanger if the concentration of the solution is greater than 50%, of the capacity of the resin (<2 N). Under the effect of the electric field, only anion pass through an anion-exchange membrane and only cations through a cation-exchange membrane. The phenomenon can be utilized for



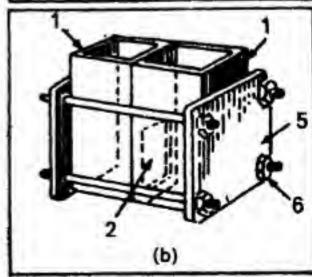


Fig. 2. Cell containing ion-exchange ments brane for electrodialysis or activity measurements. (1) Plexi-glass cells; (2) Ion-exchangemembrane placed between rubber rings; (Holes for electrodes; (4) Tap for emptying (5) Plastic plate; (6) Screws

Hg, Cl,

Hg

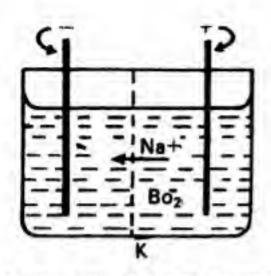
Sat. KCl

Unknown

KNO,

Hg₂Cl₂

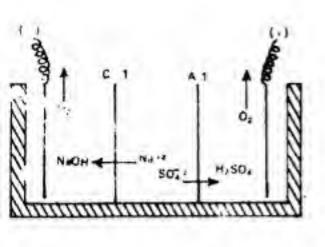
Hg



 Separation of borate ions from sodium hydroxide by electrodialysis with a cation-exchange membrane

eparations in analysis. By means of n apparatus (Fig. 3), traces of oron can be separated from sodium ydroxide solution. Under the inluence of the electric field, sodium ons travel through the membrane nto the cathode compartment, while orate ions remain in the anode ompartment. The method is suitble for determining the boron conent of sodium metal for preparing NaOH solution free from borate ons. Similarly, small amounts of phosphate ions can be separated rom vanadate ions. This method s suitable for determining the phoshate contamination of vanadium entoxide.

When the separation of ions is carried out from solutions of large colume, concentration can also be achieved by electrodialysis. For example, it is possible to concentrate races of radio-active calcium and strontium from water by means of a cation-exchange membrane in order to facilitate their determination.



ig. 4. Schematic three-compartment membrane cell electrolysis of Na₂SO₄

This type of two-compartment cell can also be used in preparative chemistry. For example, a pure acid (e.g., sebacic acid) can be prepared from the corresponding sodium salt using a cation-exchange membrane. This process has advantages over the conventional methods in that the desired product could be recovered in a very pure state without employing any other chemical reagents. This also enables the recovery of pure acids or alkalis which can be reused.

Many similar applications examined include recovery of sodium hydroxide and sulphuric acid from waste sodium sulphate, production of caustic soda by the electrolysis of brine, precipitation of magnesium hydroxide from sea water, and the reclamation of waste sulphuric acid from pickle liquor.

Recovery of waste sulphuric acid from iron pickle liquor

The waste pickle liquor contains 14%-22% ferrous sulphate and

0.5%-0.7% unused acid.

The spent liquor is the catholy while dilute sulphuric acid is the anolyte, which are separated t an anion-exchange membrane. Uni the pH of the catholyte rises t 1.8, only H+ will be reduced a the cathode. Later Fest ions wi co-deposit as metallic iron. At the same time, migration of SO,-1 ior through the membrane-togethe with the release of oxygen at th anode-results in the concentratio of sulphuric acid in the anolyte. would be economical to effect th recovery until the ferrous sulphat concentration falls down to 2.25% and to reuse it for pickling.

Three-compartment cells

A solution can be depleted of it salinity by electrolysis in a three compartment cell employing both a cation and an anion-permeable membrane. For example, if a solution containing sodium sulphate is placed between a cation and an anion exchange membrane (Fig. 4), sodium

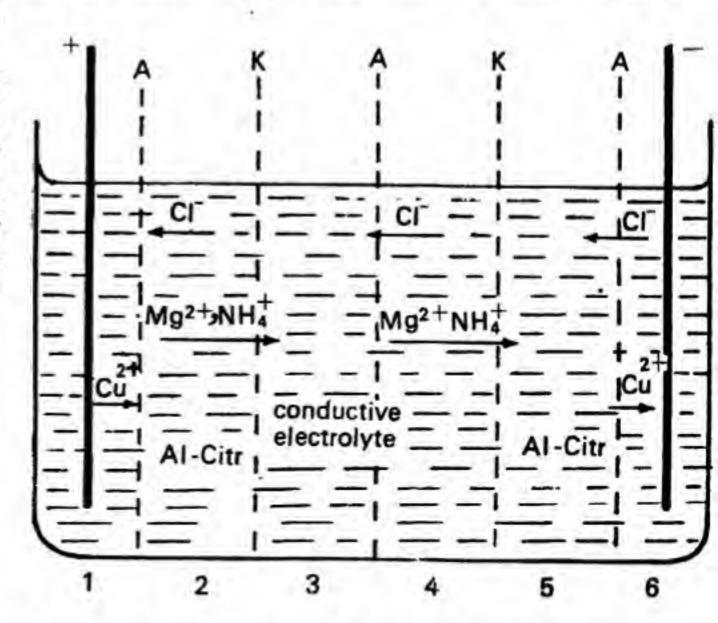


Fig. 5. Multiple compartment apparatus for carrying out analytical separations; separation of Al and Mg ions

ins can be dialysed through the ation-exchange membrane and alphate ions through the anion-schange membrane under the inuence of a voltage applied between the electrodes. Thus, during the sectrolysis, NaOH collects in the athode compartment and H₂SO₄ the anode compartment. The rinciple can be utilized for deionistion of natural waters, removal f salts from solutions and protein ydrolysates, and concentration of lectrolytes.

fulti-compartment cells

Membrane cells employing multilicity of membranes between the lectrodes have been found useful or several applications.

An arrangement of alternating nion-permeable and cation-permeale membranes between an anode nd cathode has been, in particular, nost useful for deionising electrolyte olutions with a minimum of expeniture of current. A cell of this ype is called the multiple ionxchange membrane electrodialysis MIEME) cell. Fig. 5 illustrates n assembly in which cation nd anion-exchange membranes re placed alternately. The appaatus can be employed analytically or carrying out two parallel separaions (e.g., Mo and W or Al and Mg ions) or for preparative purposes e.g., preparation of thallium nitrate rom slightly soluble thallium chloide and potassium nitrate).

Electrodialysis of water

In many arid areas of the world there exists a severe shortage of totable water. It means recovery of potable water from brackish and sea water. In this connection, distillation, ion-exchange, reverseosmosis and electrodialysis methods have received major attention. The recent developments of synthetic ion-exchange membranes have greatly stimulated interest in the deionisation of saline and brackish waters by electrodialysis. indefinite number of chambers may be alternately separated by positive and negative membranes in series, and by passing current through it, it is possible to purify it for drinking purposes. The alternate chambers can be connected in either a series-flow connection or a parallel-flow connection, both the arrangements undoubtedly possess certain practical advantages and disadvantages. Although many technical problems remain to be solved, this technique seems to be most promising for treating brackish water having 1000 p.p.m. to 5000 p.p.m. dissolved solids.

Miscellaneous applications of ionexchange membranes

In addition to the above mentioned applications, the ion-exchange membranes have been put to a large number of uses such as preparation, separation, concentration and purification of chemical compounds. Ion exchange membranes have been used in concentration of fluosilicic acid, fluoborite, sodium sulphate solution, and for electrolytic concentration of a mixed solution of chromium sulphate and sulphuric acid.

Membranes have been used for purification of sugar, whey, milk, juices, paint emulsions, sewages, alcohols, hydrochloric acid, and in cleaning of paintings.

Ion-exchange membranes have been used for the deionisation of strongly polar liquids. Acetone and other organic solvents have been deionised in freon atmosphere.

Synthetic ion-exchange membranes have been used in the construction of fuel cells. Membranes have been used as solid electrolytes and conducting media in dual membrane fuel cells.

lon-exchange membranes have also been widely used for polarization and diffusion studies, and also for water transport, conductivity, ionic mobility and thermo-osmotic studies.

They have also been used as monitors in ion exchange chromatography, for separation of amino acids into groups, in coulometric titrations, in continuous electrochromatography, and in X-ray emission spectrography.

Application of electrodialysis, using synthetic ion-exchange membranes, has proved to be a versatile technique and has been advantageously used in a large number of analytical and industrial problems. Constant efforts are being made all over the world to synthesize membranes of superior electro-chemical and mechanical properties and to design more sophisticated electrodialysis apparatus to achieve favourable economy and superior operational efficiency.

Further reading

- I. Rieman, W. and Walton, H.F. Ion-Exchange in Analytica Chemistry, Pergamon Press, 1970
- Inczedy, J., Analytical Applications of Ion-Exchange, Pergamon Press, 1966.
- 3. Kunin, R., Ion-Exchange Resins
- Helfferich, F., Ion-Exchange McGraw Hill Book Co. Inc. 1962.



Double radio sources

MAGINE an object whose size is several multiples of our alaxy's; whose total mass is equal o that of millions of suns; whose emperature is in millions of degrees; he energy it releases is equivalent to hat released by a billion suns nd is distributed over a wide range f wavelengths-from long radio vaves to visible light, even X-rays n some cases.

Giant radio galaxy is what this normously huge object is called, and here are countless of such galaxies n the universe. Close radio scrutiny f these objects has revealed them be having a double structure, and o are also called double radio ources. The study of these sources ot only enables us to understand ow radio sources evolve but also rovides evidence of the physical xistence of an intergalactic medium. The first double radio source was iscovered by F.G. Smith of Univerty of Cambridge, England. In 953, with two abandoned radio iscs of World War II, he pin-pointed e exact position of Cygnus A. e strongest radio source in the onstellation Cygnus. At a la eate, using 200 inch Hale elescor

Walter Baade and Rudolph Minkowski discovered that the position of Cygnus A coincides with that of a distant galaxy. And the final verdict on this object was given by R. Jennison and M. K. Das Gupta of Jordell Bank, England. employed a newly found technique to discover that the compact source was double in structure: two radio sources were on each side of the visible galaxy. Since then several double radio sources have been discovered. In all fairness, their prototypes can be represented by three sources Cygnus A, 3C236 and DA240. The head-tail galaxy is another typical radio source which, because of the recent discovery of its double structure, both at the air, the bubbles will grow in size, head and tail, has also been inclu- and, after a certain stage will detach

ded in the category of double radio sources.

Although all three sources-Cygnus A, 3C236 and DA240differ in size and therefore in their mass and energy-content, structurally they are of the same pattern. They have three strong radio components (Table 1). The position of the central components coincides with that of the nucleus of a visible galaxy, while the rest two are juxtaposed on exactly its opposite points. They are moving away from it at speeds on an average of a few thousand kilometers per second. Weak radio emission is littered about the components bridging the yawning gaps between them. Further, each double source has some special characteristics. For instance, the outer pair of radio components of DA240 is bulbous in appearance like two dumbbells, whereas in other sources the pair is confined; the 3C236 has two pairs of outer components instead of one as in the other two.

An analogy

An analogical situation would be appropriate here to sort out the ideas involved in models dealt with in the next section. Consider a T-shaped tube, all three ends, A, B and C, open. C is connected to a pump which forces blasts of air in the tube. The nozzles A and B are first dipped in soap solution so that thin films of soap stick at their tips. As air is pumped in, the thin films form spherical bubbles at the tips A and B. With increase in the amount of

Table 1

Radio source	Visible separation of the components	Actual size	Number and shapes of the components	Energy
Cygnus A	2 minutes of arc	Half a million light-years	Two, confined	10ss ergs
DA 240	34 minutes of arc	6 million light-years	Two, bulbous	10° ergs (approx.)
3C236	39 minutes of 4,	18 million light-years	Four, confined	10 ergs

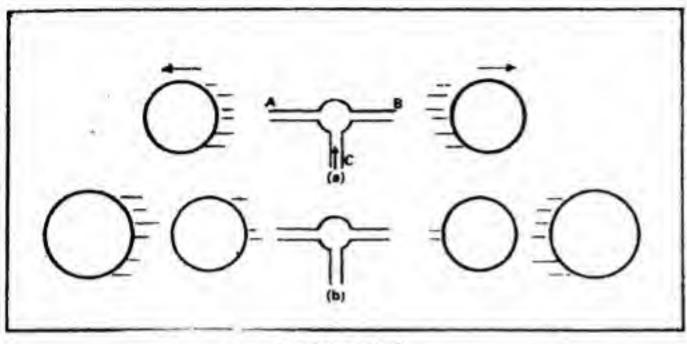
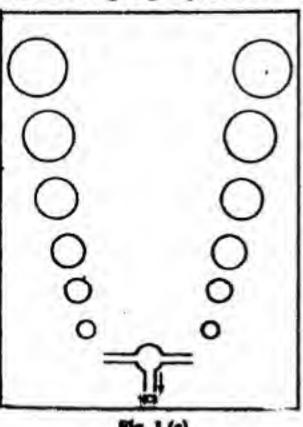


Fig. 1 (a) and (b)

rom A and B, and fly away. Such could be ubbles continuously roduced if soap solution and airump are available [Fig. 1 (a) and b)]. Now, for instance, consider hat would happen if the bubbleroducing mechanism itself moves a direction perpendicular to the notion of the bubbles. Would the icture not look like the one shown Fig. 1(c)?

If the bubbles are taken as radio omponents and the bubble-producig gadget the central radio compoent, the pictures in Fig. 1(a), (b) and c) respectively fit in with what as been mentioned about Cygnus A nd DA240 3C236 and head-tail alaxy.

The intriguing problems the



UNE 1976

double radio sources have laid before theoreticians and astronomers are mainly three: (a) since the outer two radio components are releasing energy in the form of radiation, is it that the energy is 'spoon fed' to them by some mechanism or they are themselves producing it? Whatever be the mechanism selected, the question is how it is produced and/or supplied; (b) since the outer pair of radio components is moving away from the centre, at a previous date they were with the central component just as the bubbles were ejected out of the bubble-producing gadget. But the question that arises is: How does the nucleus kick out the two components in opposite directions?; (c) as the outer components are confined and held together, what prevents them from saying 'goodbye' to each other?

Within a decade or so, many models to elucidate the above problems have been put forth but as is usual in astrophysics not a single one is impeccable.

The energy content and the 'state of affairs' inside an object can easily be judged from the measurement of energy the object is radiating in the form of radio emission. As the radio waves emitted by the double radio sources are linearly polarised, i.e., the wave of light is restricted to one plane of motion, and as theintensity of the incoming radio wave increases with wavelength, this typ cal radiation is 'synchrotron radia tion'. An object releases this emis sion if only high-energy subatomi particles (electrons, protons, etc moving at relativistic speeds (clos to the velocity of light) are spirallin in a magnetic field. From the pole risation of the emission, the directio and uniformity of the magnetic fiel can be estimated.

According to theoretical viewpoin if synchrotron radiation has bee radiated by an object for a very lon duration, a major part of the energ content should have been exhauste much before the object grew to suc immense a dimension as the doubl radio sources are now. But, a things stand, these objects are sti radiating synchrotron emissio which implies that the energy ha been stored and released in parts of continuously. The energy manifest itself in either injecting more relati vistic high-energy particles or reacce lerating the existing slowed dow ones to relativistic speeds so as t maintain the outcoming synchro tron radiation. In the latter case particle-accelerators may b stars nearing collapse, stellar mas black holes, pulsars, etc. Althoug no such compact object has yet bee detected in radio components, th powerful seats of synchrotron radia tion, the idea itself is appealing to th astronomers. This is because single pulsar, embedded in the well known Crab Nebula, has been able to provide all the required relativisti electrons that enables it to radiat radio waves and visible light.

The energy-production probles staved off, the question that come next is: Where is the energy produced It is either in all the component separately or in one componen the central nucleus, which supplie it to the others. There are tw classes of model, one advocates for the former concept and the other the latter.

In the former, the radio components are bound to each other by gravitational attraction. Both are, in fact, rotating, and as they plow through the space, they go on radiating energy which is derived from their rotational motion. The energy that these components spill out emits weak radio waves.

The model based on the latter concept is developed by Blandford and Martin J. Ress of Cambridge University, England. According to them, the central component, the nucleus of the galaxy, is the storehouse of energy for the sources. The nucleus, it is claimed, is spinning, whereby the gases prevalent inside circulate along the magnetic fields to produce nozzle-like structures at its poles. Through these nozzles only energy is beamed in exactly opposite directions, along the axis of the spinning mass, to create two hot radio components, as in the case of two bubbles in the analogy. As a consequence, this phenomenon should also create 'limb-brightening' of the radio components: as the energy piles up on the outer surfaces of the components, the edges would outshine the inner regions. However, this has not been observed so far Science, June 27, 75). In addition, he other major unexplained probems that such a transportation of nergy creates are: there is no obvious nechanism to explain how nozzles re formed in the nucleus; how the entral spinning body remains for ong (time on cosmic scales) in a articular orientation; and how eams remain stable for the same eriod.

Of the above two concepts whichwer is taken as true, one issue canot be doubted: that the two radio emponents were puffed off the entral radio nucleus of the galaxy.

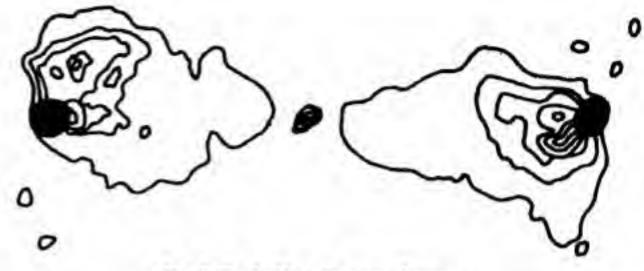


Fig. 2 The double radio source Cygnus A

Without this assumption, it is difficult in the first place to explain why the radio components are racing away from the nucleus and, secondly, why the double radio source 3C236 has two pairs of outer radio components. The problem becomes clear if the bubble production is

assertions become obvious: the parent nucleus puffs out radio components regularly. The evidence is substantial in the case of head-tail galaxy. As 3C236 is the oldest galaxy discovered to date, it has puffed twice till now, while

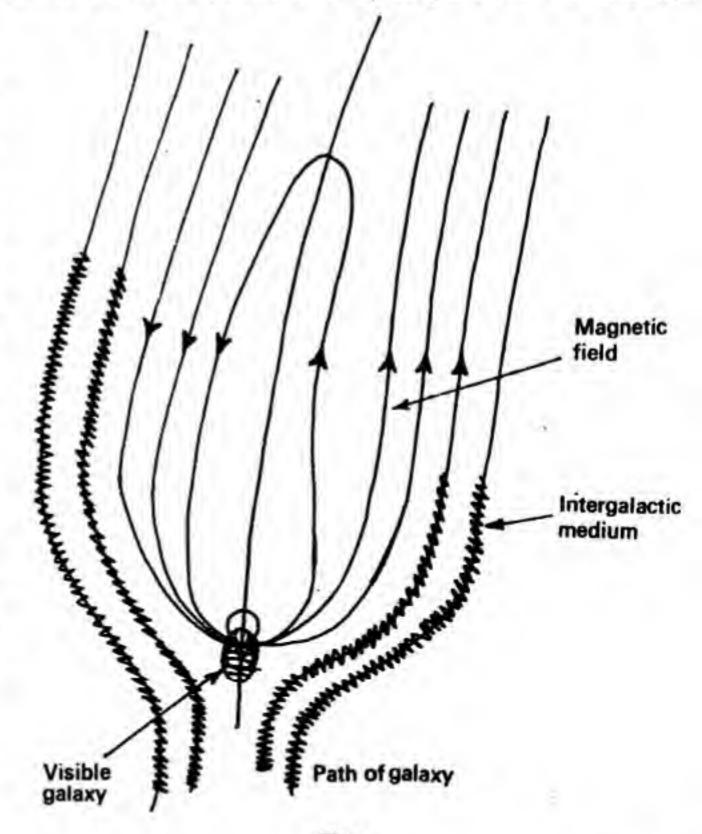


Fig. 3

the younger ones, DA 240 and Cygmus A, only once.

The question that still remains unanswered is: what causes the nucleus to puff out two radio components in exactly opposite directions? Moreover, in the case of bubble production, air is injected into a bubble only once, whereafter the bubble gets on on its own. If the bubbles are radio components, air would be the energy, indicating that the energy is imparted to the radio components only once, and not continuously as aforementioned. However, there are strong objections to the imparting of energy to a component in a single burst. From theoretical considerations, the inproportionately huge amounts of energy the radio components seem to possess could not be transferred to them in a single burst. For instance, even if it is presumed that a mechanism (still unknown to us) exists to transfer such a quantity of energy, the radio components would cool down as they expand and would drastically reduce their radio emission. Had the case been so, such objects would have escaped notice from the prying eyes of our powerful radio telescopes.

Head-tail galaxies

is that of a tadpole. It is observed n clusters of galaxies. The nucleus or head of the galaxy, which is the adio component, coincides with that of a visible galaxy, while the 'tail' is two or three million lightyears long rail that the head leaves in its wake. The Doppler shift measurement f the visible spectrum emitted by he galaxy's tail indicates the galaxs to be moving through the interalactic space at a speed of a few housand kilometers/sec. As the alaxy moves through the space, leaves behind a trail of energetic articles (electrons). If the age of

This type of galaxy has a shape

head-tail galaxy (knowing, of course, its velocity), from the point where the tail ends to the nucleus, is calculated, it is in close agreement with the value computed from the theoretical work based on galaxy's spectrum and synchrotron radiation; the age is 100 million years. Owing to this success, the above explanation that the galaxy leaves behind a trail of energetic particles-is held true. Moreover, the tail serves a good purpose as the radio history record of the galaxy -record from which where the galaxy was at a certain previous date can be ascertained.

On closer examination of tail of the galaxy, discrete blobs of radio emission have been observed. The energy, it seems, is puffed off in two opposite directions by the galactic nucleus in the same manner as the bubbles given off by the bubble-producing gadget. The blobs of radio emission are therefore these energy packets which are the double sources [Fig.1(c)]. The question that now arises is: why do the head-tail galaxies have miniature double sources, while others (Cygnus A, 3C236, DA240) have bigger and powerful ones? This is because, it is claimed, the head-tail galaxies are moving through space at such speeds as not to allow the released energy blobs (radio components) to gain much energy from the nucleus. It is, other hand, the case on the with the stationary (?) galaxies where the released energy can be continuously fed to the blob by nucleus (if nucleus is assumed to be the energy storehouse) to make them powerful ones. From the periodicity with which these blobs are observed on the trail-track, the blobs are puffed off, on an average, every few million years.

An alternate model for puffing head-tail galaxy has been contrived by Walter Jaffe and Cesare Perola

at Leiden Observatory, Netherland (Scientific American, August 1975 They claim that such a galaxy, whi hurtling through space, produce galactic magnetosphere (Fig.3) ju as earth's magnetism produces may netosphere while passing throug a stream of energetic particle called Solar Wind. The energ liberated during explosions in th nucleus is injected into the magneto sphere to accelerate particles. A a result of the spiralling magneti fields, the synchrotron radiation is emitted along the tail. Recently a clear-cut evidence for such magnetic field has been observed

Intergalactic medium

The most cogent evidence for the physical existence of an intergalactic medium comes from these sources. The following two instances make this apparent.

As radio components are nothing but gases in turbulent states with subatomic relativistic particle: spiralling in magnetic fields, it will not be wrong to call them 'clouds'. However, there has been found a difference in their shapes. For example, the components of DA240 are bulbous while those of Cygnus A confined. A plausible explanation is that DA240 is in a higher state of evolution than Cygnus A; as a cloud of gas, which is expanding at a high speed through a medium, grows in size, the ram pressure (the pressure that builds up at the leading edges of a cloud of gas which is expanding at a high speed through a medium) exerted by the intergalactic medium opposes it and, in addition, decelerates it. That is why the clouds are confined in the case of Cygnus A. At a later period of evolution-the state in which DA 240 is at present-with the decrease in the expansion rate of the clouds the resisting pressure of the intergalactic medium also decreases.

This allows the clouds to grow in a normal manner-equal expansion in all directions-to take the bulbous shape. The discrepancy in this explanation does not become obvious unless one point is stated: that the immense energy in the clouds is not uniformly distributed; it is confined only to two small regions inside, which are the hot radio components. So it counts against the assertion that ram pressure alone resists the expansion of a region stuffed with inproportionately enormous amount of energy. There must be prevalent in addition some other pressure, of which we are still unaware.

The other impressive evidence for nedium in the intergalactic space is provided by head-tail galaxies. The settling down of the energy packed blobs, which the galaxy ouffs out, into the surrounding pace in itself carries home the point hat there is a medium which resists he blob from moving with the nucleus of the galaxy. Further, t has been observed that the tails f such galaxies are curved. This ndicates that turbulence is present n the medium, which causes the tail o turn. It appears more conclusive han assuming for no reason that the alaxy itself is turning in lue to gravitational influence. The

phenomenon is, more or less, like the drifting of the bubbles from the bubble-producing gadget along the direction of the wind, whose direction of motion is other than that of the bubble producing gadget. It is now understood that the medium contains gas whose density in intergalactic space is three hydrogen atoms/litre.

The crux of so many baffling problems that face the theoreticians in carring out a perfect model for the double radio sources is the energy emission. On the scale the energy is produced and emitted by these objects is inexplicable. In other words, no energy-production mechanism hitherto known, e.g., thermonuclear reactions, can account for it. It is suggested that the process utilised by that mechanism may be the complete annihilation of matter-when mass is annihilated, it releases energy hundred times more than what fusion process would release for the same quantity. All this implies that by the study of double radio sources, we are intruding into the domain of a mysterious phenomenon at work. How much we shall succeed and what benefits accrue from such a study time only will tell.

DILIP M. SALWI

Pi in terms of a new fraction

40 000 000 000 000
71 887 338 539 247 represents a alue of w upto corrected fourteenth lace of decimal or upto 15 signicant figures.

THE ratio of circumference to diameter of a circle is a niversal constant, and is denoted by the Greek letter w (Pi). The ratio is independent of the size of circle and is a real but irrational number; its decimal equivalent is a non-repeating number, i.e., it is never-ending. Moreover, it cannot be a root of an algebraic equation with real coefficients. This property is known as transcendence of w, and was proved by F. Lindemann of Germany in 1882. Again, as w possesses an

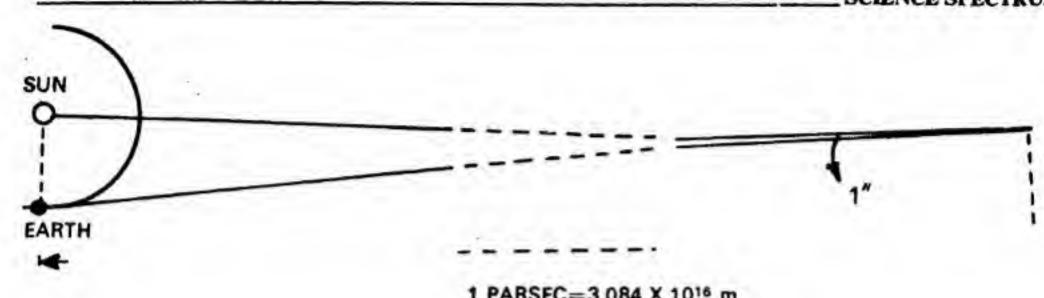
irrational value, it is impossible to draw a circle of area A where A stands for the area of another smaller circle. In other words, no circle can be squared up the form of another circle.

The value of w upto corrected 20 places of decimal (Adele Leon hardy, Introductory College Mathematics, p. 84, John Wiley & Sons New York & London, 1963) 3.141 592 653 589 793 238 46... With the help of an electronic computer the value was successfully compute upto 100 000 places of decimal (D. Shanks & J.W. Wrench Jr. Mathematics of Computation, Vol 16 pp. 76-79, 1962) at the beginning of the last decade.

For the estimation of the value of *, historical evidence of the variou attempts made through the ages ar available. An ancient Chinese and a Hebrew book assumed a value of 3.0 for #. Archimedes, in the 3rd century B.C., showed that the valu of w lies between 3 1 and 3 10 For calculating it, he took the help of a regular polygon of 96 side inscribed within a circle. Aryabhata an Indian mathematician of the 11th century, expressed w as 20 000 which comes to 3.1416. His contemporary Italian mathematician Leonardo Fibonacci, gave its value as 824 274 . i.c., 3.007 Aryabhata's estimation of w may be considered

to be the first successful attempt

CIENCE REPORTER



1 PARSEC=3.084 X 1016 m Fig. 2

arriving at a fairly correct alue. An Egyptian book named of the 17th hmed Papyrus entury gave this ratio as 1605. A Sanskrit book Lilavati ritten by Bhaskaracharya, ndian mathematician of the 12th entury, shows the following rule Bhāskarāchārya, Lilavati, Translated Edited by Colebrook and Banerji, . 115, Kitab Mahal, Allahabad, 967) for the estimation of w.

"Rule 201: When the diameter vyāsa) of a circle (vritta) is multilied by three thousand nine hundred and twenty-seven, and divided by welve hundred and fifty, the quotient the near circumference (paridhi) of hat circle; or, when the diameter multiplied by twenty-two and ivided by seven, the gross value of a circumference is obtained."

The first part of rule 201, which is pparently derived from Aryabhata's raction by dividing both numerator and denominator by 16, gives its ralue as 3.1416. This is true upto corrected fourth place of decimal. The second part of the rule yields a till less accurate value of 3.142 857...

or $\frac{22}{7}$, which is still used for rough alculations. It is true upto corrected third place of decimal.

During the 17th century, different nathematical series (S.R., 11, 10, p. 189, 1974) involving were obtained in the West. They provided new grounds for estimating the value of

w. Towards the middle of 19th century, William Shanks in Europe was able to estimate # from mathematical series upto 707 places of decimal by doing painstaking calculations. No evidence of any other serious attempt to express # as a fraction having accuracy more than Bhāskarāchārya's fraction can be traced, though recently computation of the value of # has already been made accurately upto 10° places of decimal.

The author has derived a fraction 540 000 000 000 000 for m. 171 887 338 539 247 checking its value, its decimal equivalent has been found to tally upto fourteenth corrected place of decimal, i.e., upto 15 significant figures. It should be noted here that the suggested fraction has also 15 significant figures in the denominator and 2 significant figures in the numerator. So, no better accuracy can be expected from the fraction. method adopted to arrive at the fraction is given below.

When a rotating radius, r, of any circle makes a complete revolution, one end of it forms a circle whose perimeter, p, equals $2\pi r$ by definition. When the radius is rotated through a small angle such that a small arc, δp , of the circle subtends an angle of 1 second (1°) at its centre (Fig. 1), the ratio $\frac{\delta p}{r}$ then represents the angle (1°) expressed in radian. The conversion value from radian

to second for angle (L.J. Coomrie Chambers' 6-figure Mathematica Tables, Vol II, p. 579, W. & R. Cham bers Ltd., Edinburgh & London 1972) is:

I radian = 206 264." 806 247 0964 One complete revolution of radius corresponds to an angula displacement by 2π radians of 360° or 1 296 000," which means that p=1 296 000 $p=2\pi r$.

The last fraction is obtained by dividing both the numerator and denominator of the previous fraction by 12.

It is further noted that a bette fraction with more significant figure in numerator and denominator may be arrived at, if the conversion valufrom radian to seconds is computed upto more significant figures than 1 as assumed in the above deduction.

The concept of a small angle of I may be compared with a similar angle in the definition of 'Parsec', which i an astronomical unit of length Parsec is the largest unit of length ever conceived and is larger that lightyear. Parsec is the distance from earth to a far distant point, P in space at which the mean distance

for earth to sun makes an angle f 1 second at P (Fig. 2). It is nearly $.086 \times 10^{16}$ metres.

It is worth mentioning here that ne new fractional value of w may e utilized in future to arrive at a nore precise value of the astronomical unit of length, Parsec, in terms of metre.

Deptt. of Physics Jadavpur Univ. Calcutta-700032 results. According to some, polywater is a reality while other refute it. They say that the residual claimed to be polywater is not pure H₂O but simply impurities leached from the capillaries or from the vacuum system. The matter has no yet reached a definite conclusion.

Does polywater exist?

WHAT is polywater? It is claimed that "polywater is a polymer f pure water with properties somehat more like those of a real polymer han those of ordinary water". The laim is certainly exciting, and scienists in different parts of the world are ngaged in the study of polywater. lut whether polywater is a reality or ot has not yet been conclusively stablished. Many scientists are ot ready to consider polywater or nomalous water to be pure H₂O. according to them, it is a boraceous, iliceous or carbonaceous hydrate. Polywater was first discovered by N.N. Fedyakin in USSR and extenively investigated by B.V. Derjaguin t al. at Institute of Physical Chemistry, Moscow. Its properties liffer much from those of ordinary vater. It is a viscous, gelatinous ubstance apparently produced from rdinary water and miscible with t. It can be produced in a very mall quantity in fine capillaries by he process of evaporation and

roduction of polywater specimen

ondensation of ordinary water.

A bundle of freshly drawn fused ilica or borosilicate glass capillary ubes, having lengths of the order of 1 cm and internal diameter etween 2 \mu m and 50 \mu m, is suspended in a vacuum system, generally a acuum desiccator, and exposed to vater vapour for several days. For obtaining excellent results

saturated water vapour is not used but the saturation of water vapour is kept within 95% to 98%. For obtaining the requisite saturation of water vapour, the vacuum system alongwith the bundle of capillary tubes is kept at a fixed temperature by the use of a thermostatic arrangement. The distilled water placed inside the vacuum system is kept at a temperature 0.3°C to 0.5°C lower than the vacuum system by the use of a separate thermostatic arrangement. After several days the capillaries are found, under the microscope, filled with a colourless liquid. This liquid is considered to be a mixture of ordinary water and polywater. Its properties are found to differ from those of ordinary water. When evaporated at room temperature under exposure to laboratory air, the liquid gives a more condensed solution of about 0.1 µgm which is considered to be a 10% solution of polywater in ordinary water. The solution is transferred from the capillaries on to a metal or silica plate by blowing or by centrifuging. It is evaporated in vacuo and recondensed into another capillary. This recondensed polywater solution leaves, after some evaporation in vacuum, an almost solid residue. This is claimed to be pure polywater.

These experiments require great skill and patience, and different scientists have obtained different

Properties of polywater

Derjaguin and his coworkers die not at first visualise that polymor phous form of water can exist outsid the capillaties. Hence, they measu red the bulk properties of the poly water specimen without bringing th specimen outside the capillaries in which it was formed, after removin from it as much ordinary water a possible by the process of evapora tion. It was found that the visco sity of the polywater specimen wa 12 to 15 times greater than that o ordinary water and the coefficien of volume expansion of the specimes was about 50% higher than that o ordinary water at the same tempera ture. The density of the mixture of polywater and ordinary water wa found to be 1.39 gm/c.c. Polywate could be supercooled to a much lowe temperature and much more easil than ordinary water, but on reheat ing quasi-melting was 'observe between -15°C and -30°C. Durin quasi-melting state the length of th polywater column changes at relatively higher rate but the chang is rather small-about 5% only So the solid formed from polywate cannot be ordinary ice. When th mixture of polywater and ordinar water is heated from -5°C to 0°C the two separate into two differen phases, though at the origina temperature only a single phas exists.

The refractive index of polywate is 1.48. It was found to be birefring ent. According to the Lorentz Lorentz equation this value of refractive index is consistent with

s maximum density. It is assumed at the molar refraction is the me in the two species. Polyater remains stable well above 00°C. The exact boiling point is ot known. The accuracy of the neasurements of the physical properes of polywater such as viscosity y Derjaguin was doubtful due to ne fact that concentration of the nixture of polywater and ordinary ater in the capillaries (on which ne measurements were carried out) as unspecific and the properties f pure polywater were calculated directly by extrapolation.

polywater a reality ?

There are many reasons to doubt ne existence of polywater. Many ttempts have been made to repeat Derjaguin's experiments but with arying degrees of success. Residues ave been obtained, but all the neasured properties do not tally xactly with those of Derjaguin's xperiments. Many factors may be esponsible for this. According to ome workers the residue is not pure olymorph of water, but a substance ached from the walls of the apparaus: a crystalline condense of an lectrolyte, a siliceous or boraceous ubstance or a carbonate.

The most significant evidence gainst polywater is the results of he electron microprobe analysis. t is an X-ray spectroscopic method. finely focussed electron beam of nergy, sufficient to excite charateristic X-ray spectra, is scanned n the residue (which is claimed to e pure polywater specimen) and the avelengths of the characteristic -ray spectra are determined. The nethod is sensitive but not absolute. he signal must be calibrated by omparing with a prepared specimen. Jsing the electron microprobe nethod E.R. Lippincott and his oworkers of the University of Maryand, USA arrived at the conclusion that the residue, though not absolutely pure, was fairly pure; whereas most other workers such as S.W. Rabideau and A.E. Florin of the University of California found the presence of some impurities such as Na, K, C, Cl, and smaller quantities of Ca, B, N, Si and S. Comparing the signals with that of oxygen or independently prepared specimens of impurity substances of known mass, it was found that these impurities usually form an appreciable part of the polywater specimen.

One may now question how these elements form a part of the polywater specimen. This may be due to the evaporation of electrolyte ion from the solution. It is found that on evaporation of the liquid specimen from the capillaries, crystalline K₂SO₄ deposit is obtained if instead of the temperature differential method a saturated K₂SO₄ solution is used for obtaining 98% saturated water vapour.

Another significant fact is that polywater specimen is not obtained if instead of a glass vacuum desiccator a plastic vacuum desiccator is used. Again, it is very difficult to form polywater specimen in moist capillaries, and freshly drawn capillaries are needed to get polywater. But this does not prove that leaching plays an important role. It only proves that silica or glass surface is closely involved in the formation of polywater. May be the alkali concentration is relatively higher on a freshly drawn silica surface which accelarates leaching. One very interesting feature is that polywater cannot be prepared from heavy water (D.O).

Some workers are not ready to consider polywater a reality on the ground that infrared absorption spectra, almost similar to that for polywater (obtained by, Lippincott and his coworkers), is obtained for various aqueous solutions.

The Birkbeck College group, Ur

versity of London, has found that if the vacuum system used for the preparation of polywater specimen is no free from oil, the polywater specimen is found to contain traces of carbon under electron microprobe analysis though it is free from silicon and othe impurities.

In some experiments it tool a much longer time for any liquid to be condensed in the capillaries, when oil-free vacuum systems were used. The condensed liquid evaporated completely to dryness without leaving behind any residue. It is not an indirect evidence that all residues are impurior, conversely, the liquids which do not give any residue are pure?

In a new book (Recent Advance, in Adhesion edited by Lieng-Huan Lee of Xerox Corpn., New York & London, 1973), Derjaguin has con curred with his former opponents that the observed properties are caused by the presence of impurities rather than by a new structure of hydrogen and oxygen atoms. He states that he and his co-workers, using an electron probe technique, detected Si and/o some other impurities in even the cleanest samples of anomalou material. Even then several pheno mena still remain unexplained. On mystery, Derjaguin feels, is that fresh water vapour condensate appears to dissolve quartz and impurities mon readily than aged liquid water.

An explanation of this phenomenon has been proposed by Barr Brummer, Environmental Impactority Centre, Cambridge. He feels that the material present will dissolve equally well in either liquid of vapour. However, in the case of water vapour the amount of water is so small that the initial material that dissolves produces a moralkaline solution than liquid water hence it dissolves more readily other materials.

A second unresolved question

the exact nature of the material that is called polywater. Many impurities such as Na, B, Si, C have been found in varying degrees in the samples prepared by various experimental groups. Yet no one knows which of these elements are essential constituents of the anomalous water.

Structure

It is difficult to conceive that liquids can have any structure, because phenomena such as Brownian motion, etc., show that the molecules of a liquid are at random motion relative to each other. Hence, by liquid structure is meant the instantaneous structure of the liquid or the time-average of certain features of the instantaneous structure.

Ordinary water has asymmetrical O-H...O hydrogen bond between two oxygen atoms. The bond energy is about 4.5 Kcal/mole, about 0.2 V. But in case of polywater, stronger hydrogen bonds may exist which earn large differences in the properties of water and polywater. Such a bond might involve a different set of molecular orbitals and can play an important role in liquid-solid interface problems.

For solving the structural problem, one must consider the results of some physical measurements on polywater such as the mass-spectrum, NMR, K-ray, diffraction, infrared spectra ind Laser-Raman spectra. Mass pectrum helps in determining the nature and proportions of the impuities. The presence of impurities was found to be low on mass-spectrocopic observations of the vapour hase. But this might be due to the ow vapour pressure. It was suggesed that polywater exists as (H,O), lusters which vaporise without dis-However, ociation. the pectroscopic study of the vapour hase reveals that this is not so.

Though the proposed strong bond energy for polywater is consistent with its low vapour pressure and high temperature behaviour, a question naturally arises: if the bond is so strong, why is it not present at least in small quantities in ordinary water? Again, the miscibility of polywater with ordinary water is difficult to explain on the basis of the polyelectrolyte structure. However, the bond of the type (O-HO-) may exist but whether it actually dominates is another thing.

Methods of molecular orbital calculations have been adopted to throw some light on the problem of OHO bonds. On the basis of such calculations L.C. Allen of the Princeton University, USA, and his co-workers have proposed an electrically neutral structure having conjoined planar/hexagonal rings. Three types of lattice have been suggested. The properties of polywater such as its density, viscosity, low and high

temperature behaviour, birefringeneral and its NMR spectra are all consistent with these structures. In the structures the bond energies are comparable to those in ordinary water, but the geometrics of the structures are different from that cordinary water.

Though quite a good amoun of research has been carried or on polywater, its existence or nor existence is still very much an ope question. Researches on polywate are still in progress in different labor ratories and may have much sign ficance in the field of science. Eve though pure polywater has no reexistence, the structural studies of polywater, including molecula orbital calculations, are valuab because they probably apply to wat interface systems.

> PRADIP KUMAR DATI Deptt. of Physic Hooghly Mohsin Colleg Chinsura, Hooghly (W.B.

Synergistic phenomena

Gold dissolves neither in hydrochloric acid nor in nitric acid. But it readily dissolves in a mixture of these acids(1:3). If you take an analgesic like novalgin or aspirin along with alcohol, you teel far more depressed than when alcohol or the analgesic are taken separately. Similarly when tomato plants are sprayed with certain mixtures, we can harvest increased yields. But when the constituents of these mixtures are tried individually, the yields are lower.

These are examples of synergistic phenomena. Though the name appears strange, it has been used in several fields through centuries. Synergism is a phenomenon wherein the additivity rule does not apply. The phenomenon is displayed when two or more agents when used together produce more effect than the algebraic sum of the effects produced when the agents are used singly. For example, take the simple case of a mole

of gas A producing a pressure of on atmosphere in a certain vessel and mole of another gas B alone also producing the same pressure in the same vessel. When both A and I are introduced into the vessel, the pressure is not what we expect it would be, but slightly more—about 2.2 atmospheres. This is an example of synergistic action where two gases (agents) present together produce a pressure (effect) more than that caused by the individual gases.

In general the synergistic effect produced by interaction of two of more agents may be temperature colour, solubility, toxicity, etc. May be, one can cite an example of synergism in decency and comfort too imagine two men meeting, one is small but wears an outsized coat, the other is tall and his coat is splitting at the seams. Obviously, the best course of interaction for them would be to swap coats and part amicably No worry for either, both gained in the bargain.

There are cases where the fect produced in the presence of wo agents is less than the additive alue. These cases come under antimergism, negative synergism or nore commonly called antagoism. No synergistic action is said occur when the combined effect just equal to the additive value.

One comes across a large number f examples of synergistic action in ny field. In mixtures of agents f chemical nature, the concentraon of the agents is very important. only with certain proportions of gents, pronounced effects are notieable. That is why synergistic comositions of mixtures of agents are ften reported. Of late, much inerest has been shown in discovering gents which enhance the characterstic effect produced by a particular ubstance. A few examples ynergistic phenomena are given elow.

A considerable percentage of iron, teel and non-ferrous metals like coper, tin and zinc produced every tear are ingloriously lost by metal corrosion. Corrosion weakens metals and alloys and robs them of their valuable properties. Any attempt to reduce the loss due to corrosion would pay a lot. Researchers have come out with highly promising solutions — synergistic mixtures for inhibiting the corrosion of ferrous metals, copper and zinc.

Tetraethyl lead emerged as an antiknock agent through the brilliant chemical deductions of Midgley (Britisher) and this development has had a tremendous effect on the utiliration of gasoline. The saving to the consumer has been immense, running to billions of dollars each year. The performance was further improved by a later discovery that tetraethyl lead behaves synergistically with methylcyclopentadienyl manganese tricarbonyl. Synergistic lubricant mixtures are also available.

Surgery has now been made much less painful by the improved performance of synergistic anesthetic mixtures.

Carbon monoxide is a poisonous constituent of the exhaust gases of automobiles. Synergistic mixtures are proposed for reducing its content in these exhaust gases. These mixtures are particularly useful in our industrially advanced cities with heavy vehicular traffic.

Catalysts are a vital need in indusstry for making a particular chemical reaction go in a short time. Synergistic catalyst combinations help the reactions go at much faster rates.

An interesting case of synergism produced in colour and solubility is made use of in the analytical chemistry of copper. In a mixture containing copper (II) pyridine and salicylic acid, a blue compound (mixed complex) is formed, which is more intense in color than the copperpyridine (I) or copper-salicylic acid (II) complexes. Moreover, the mixed complex readily dissolves in chloroform while (I) and (II) do not dissolve. By measuring the colour in chloroform, the amount of copper can be estimated according to an extractive photometric method suggested for copper.

It is well-known that more than twenty of the naturally occurring elements are essential for the life processes to proceed. The interaction of these elements is very complicated. The utilization of a certain element is profoundly influenced by the presence or absence of another element. An animal deprived of copper (but not iron) develops anemia suggesting a synergistic action between copper and iron.

Some combinations of agents are very harmful. For example, certain associations of microorganisms are involved in the spoilage of most kind of foods. Two microorganisms can be synergistic in bringing about changes that neither could produce alone. To take another example of harmful combinations, saccharin is the cheapest available non-toxic synthetic sweetener consumed by diabetics and also used for sweetening food and drinks. It is unfortunate that this sweetening agent becomes cocarcinogenic when used with even small amounts of a chemical carcinogen which alone does not produce cancer in such small amounts. Similarly, freons and certain insecticides when used together are found to produce cancerous tissue, while they produce no undesirable effect when used singly.

A number of solid and liquid micro-nutrient mixtures (containing iron, copper, zinc, boron, manganese, etc.) are recommended for crops for increased yields. Farmers have to be very careful about their usage. The soil has to be tested and only when it is found necessary, these micronutrients can be applied, that too, in the required amounts. Excess amounts will be beneficial toxic and poison the effect of another micronutrient, besides adversely affecting its intake.

Similarly, though amino acids are important for human body they lead to a number of disorders in the body, if taken in disproportionate amounts. The ability of sheep or cattle to absorb copper is greatly influenced if too much zinc or molybdenum is present in their diet. This is an example of antagonism between copper and zinc or molybdenum. In order to correct anemia, a check on the dietary levels of zinc and molybdenum is thus necessary for proper absorption of copper, which in turn

exerts a synergistic action on the utilization of iron.

Although thousands of examples of synergistic mixtures are available, the mechanism of such action is not ye: fully understood in all the cases. However, scientists wondered as to now substances behave when they ire alone or when other substances are also present. They are convinced that a molecule behaves differently when in close proximity o other molecules (even if they are exactly similar to themselves). For xample, the behaviour of a single molecule of water would be different in that it would not boil it 100°C or freeze at 0°C, as water n a beaker does. You would not and individual molecules of H₀O in beaker of water. What you find s agregates of H_aO molecules best epresented by (H₂O), where n is a imple integer more than 1. It is this nteraction between water molecules which modifies and is responsible or all the behaviour that water xhibits. The interaction between gents in certain systems probably an explanation at the nolecular level, the degree of interacion depending ultimately on the tructures of the agents and other

parameters. Of late, we have been witnessing lot of demand for materials like ood, fuels, fertilizers and medicines. The need for their effective and conomic usage is well recognised. ynergistic mixtures are of particular elevence in this connection. However, he interaction of the constituents f such combinations and the effect f such interaction on life processes ave to be thoroughly understood. The ban order imposed by the ederal Government of Canada on he sale of all pain-killers that contain henacetin in combination with any orm of salicylate, is a good example f such awareness. The ban was esult of experimental studies which

suggested that products containing acetylsalicylate, phenacetin and caffeine (APC) cause more kidney toxicity than phenacetin alone.

In view of the potentialities held by synergistic phenomena, the discovery of more such phenomena is always awaited as well as a thorough understanding of their mechanism. Those who have actually worked on the synergistic phenomena, witnessing the enhanced effects produce by mixtures of agents will be appreciate the Oxford Englis Dictionary meaning of the wor synergism: the doctrine that the human efforts cooperated with the Divine Grace in the work of regeneration and salvation of the soul

V.V.R. SASTR Regional Res. Las Bhubaneswar-

Disc electrophoresis

ISC electrophoresis, a new remarkable analytical method, was developed first in the Cell Research Laboratory of Mt. Sinai Hospital in New York. It is capable of making separations of substances of high molecular weight which could not be achieved with greater resolution by paper or starch gel electrophoresis. The technique is called disc electrophoresis because highly concentrated protein stack separates out in thin layers of as little as 50 microns thick that resemble a stack of flat discs in the gel column and also because the technique involves a discontinuous pH boundary during stacking, preconcentrating phase. A large number of substances

like plasma proteins, mucoproteins lipoproteins, nucleoproteins, hemoglobins and haptoproteins; a variet of enzyme proteins (isozymes) like ribonuclease, amylases, dehydrogenases, transaminases, transpeptidases and carboxylases and a variet of other substances are successfull separated by this method.

Key to the success of this technique is the advance preparation of polyace rylamide gel and the method of loading it in three stages into operended cylindrical glass tubes of 8 mm diameter. The sample is mixed in an anticonvection medium. Next a 'staking' layer of relatively large pore size is polymerised in the tube. A separating gel of different



Fig. 1

H and small pore size is loaded and olymerised above this. According their electrophoretic mobility, ne sample ions concentrate in a nin disc at the interface between acking gel and separating applied. hen current is ands move and separate along the noving pH boundary across a near voltage gradient. The eletrophoresis may be carried out y using either a single gel or a nown percentage or the gel may onsists of three sections: (1) a large ore anticonvection gel containing ne protein sample, (2) a large pore pacer gel in which electrophoretic oncentration takes place, and (3) small pore gel in which electrohoretic separation is accomplished. When the sample crosses the interice into the separating gel, a moving H boundary sweeps through them nd separation begins in a linear oltage gradient. The effect of

ectrophoretic mobility is enhanced y a physical 'sieving' as the large polecules pass through the gel pores. Electrophoresis is complete within alf an hour and the gels are removed om their tubes and placed in stains f various kinds to identify the varius types of proteins. If necessary, xcess of stain is removed in destainng tubes and electrophored for 45 ninutes. The individual bands on ne gels can be photographed or anned photometrically to chart the ensities and spacing of the separaed bands. Sections of the gels can be ut apart and the contained fractions valuated for chemical, radiographic r immunological assay.

dvantages

It has a number of advantages over tarch or paper electrophoresis:

1) It is hundred times more sensitive han starch gel and paper electrohoresis; (2) concentrates protein rom dilute solutions before separaion; (3) it is more reproducible than either paper or starch gel electrophoresis; (4) the bands are clear and transparent; (5) it is faster, and works within half an hour to one hour, whereas paper or starch takes more than 10 to 12 hours; (6) the electrophoretic tark holds many gel tubes in a minimum space; (7) the gels are quite inert; and (8) it is simple to understand and easy to handle.

Effect of pH and porocity of gel

With change of pH, the electrophoretic mobility of proteins varies
due to the ionisation of COOH to
COO and NH, to NH, +. Therefore, the ionic strength and so the
conductivity of the buffer must be as
low as possible because higher mobilities can be achieved with minimum
heat. Depending on the size and

molecular weight of the protein molecule, pore size of the gel can be adjusted to the desired state.

Applications

Data obtained by disc electron phoresis have been used in diagnosing and monitoring of patients of acut schizophrenia, cancer of breast, lives pathology, milk allergy, mycolom and tuberculosis, etc. It also aids in the identification of seed proteins prot, insparticipating in the morphogenetic phenomenon of plants and pathological condition of plants, etc.

S.B. NARASIMHAREDD P.M. SWAM Deptt. of Botan S.V. University, Tirupath

Perils from pollens

DOLLEN grains represent the I highly reduced male gametophyte of flowering plants comprising a vegetative cell and a generative cell or the two sperms. The grains are transported by air, water, insects or birds to the stigma of another flower (of the same or a different plant). Soon after arrival, they germinate and form pollen tubes which carry the sperm to the female gametophyte. The grain wall, consisting of thick, resistant exinc and a membranous intine. has for long been considered a protective corpus-fending against any harmful influence of maternal sporophyte, and later the rigours of external environment. Recently, it has been shown that these wall layers are also the seat of complex enzymic and antigenic proteins which flow out within moments of alightment on the moist stigma, and are involved in germination of pollen, dilation of the serm pore for emergence of pollen

tube, and dissolution of the cutical to pave way for pollen tube entrinto stigma. The effused pollen was proteins also react with analogoup pistillate proteins to determine whether the grain will germinate and if so, whether the tube wis successfully traverse the style (the recognition reaction).

These pollen proteins are also th cause of several allergic disorders i some such as hay-fever (characterize by intense sneezing and cough accon panied by itchy, watery eyes), urt caria (eruption of the skin), rhinit (inflammation of nasal passage and asthma (constriction of fine air passages resulting in difficult in breathing, and wheezing) huma beings. Allergy is an altere or acquired state which results i abnormal response of the body t substances normally harmless. Du and insect debris can also induce i but pollen is the major aeroallerge The grains of most plants contain a small fraction (0.5% to 1%) of their total protein content as allergen (substances capable of causing adverse reaction in the body). However, only the wind-pollinated plants are troublesome because of the abundance of their pollen in the air we breathe. An idea of the amount of pollen grains produced by these plants can be had from the example of ragweed, a single plant of which can generate 40,000,000,000 of pollen grains per day. The grains of some plants are so light (6,000,000,000 in certain grasses would weigh an ounce) that they are blown to distances, hundreds of kilometers way.

Sources of allergy

The understanding of the complicity of plants in bringing about certain 'seasonal diseases' has been gradual. To begin with, odours manating from flowers, such as oses, were implicated. Towards the nid-ninteenth century, J. Elliatson 1831), a British scientist, suggested hat grass pollen caused hay-fever. Subsequently, a noted American loctor and social reformer, Morrill Wyman (1872), experimentally demoistrated that the mucous membrane of hay-fever patients was abnormally ensitive to pollen. Since this realiation, the list of plants that have een tracked down as sources of collens responsible for generating llergic reactions has been swelling. Mulberry (Morus alba), Populus spp.), eucalyptus (Eucalypus spp.), Oak (Quarcus spp.) and ycamore (Platanus spp.) rees; rye (Secale cereale), cattail Phleum pratense), bermuda grass Cynodon dactylon), wild oat (Avena ativa) and bajra (Pennisetum typhoieum) among grasses; Primula vulgaris) and chrysanthenums (Chrysanthemum spp.) among rnamentals; and ragweed (Ambrosia

spp.), sagebrush (Artimesia spp.), prickly poppy (Argemone mexicana), salsola (Salsol spp.) and castor (Ricinus communis) among weeds, are some of the plants which are common causes of allergy. Hypersensitivity to pollen is noticed only in the season in which the plants flower, i.e., spring for trees and most of the weeds, and summer or rainy season for majority of grasses. Nearly ten per cent of human population is prone to this scourge.

Nature of allergens

The chemical constitution of allergens has been the subject of several investigations. Rosa Augustin (1959), an immunologist at the Liverpool University, U.K., confirmed that the antigenic property is retained in the protein fractions after sugars, peptides and pigments are removed from pollen extracts. The capacity of rye grass pollen is not lost when the extract is treated with carbohydrate-metabolising enzymes, thus setting to rest earlier belief that several carbohydrates too were involved. The allergy-causing proteins in ragweed have been figured as acidic globular proteins with molecular weight ranging between 30,000 and 40,000 daltons. In rye pollen grains, W. Jorde and H.F. Linskens (1972) of the Botanical Laboratories, Nijmegen, The Netherlands, have estimated that the principal allergen in soluble protein fractions has a molecular weight of 20,000.

Human response

Pollen-laden air enters the nose or mouthby breathing and passes into the windpipe through the vocal cords. The windpipe is held open by rings of cartilage and is lined by a mucous-secreting membrane covered by numerous tiny hairs. These hairs continuously waft a sheet of sticky mucous upwards which traps any dust, pollen grains or other

small particles that might have been inhaled. Since the pollen protein are soluble in water, they are leached out within a few seconds and calessily diffuse across the mucoi tissue. It has been suggested the probably they traverse the membran in the form of a complex with boros which is known to be essential formaximal allergenic effect.

The response to allergen varie with individuals. For example ragweed pollen usually produce inflammation in the nose and eye where it first makes contact wit body fluids. Some persons, however develop asthma or hay-fever, an still others may have headache The mucous tissue and bloom of allergic persons contain a high concentration of antibodies-prote ins which clump with anye xtraneou antigens, rendering them harmless Whereas in a normal human blood serum only three groups of antibodie are formed, i.e., immunoglobulin A G and M, in the blood of allergic patients two other antibodies, immu noglobulin E (IgE) and immuno globulin ND (IgND) also exist a very low concentrations. The poller antigens from complex with Ig E and probably also with IgND antibodies These complexes disturb the metabolism and cause release of certain 'mediators' such as histamine, acetylcholine, heparine and serotonin. from the mucosa cells or the leucocytes. Histamine, the major secretion, is an organic base, generally released from tissues when they are injured, causing dilation of local blood vessels, contraction of smooth muscles and fall in blood pressure. Its discharge in the bronchial region provokes intense spastic contraction of the smaller air passages resulting in convulsive breathing and wheezing, so characteristic of asthma and hay-fever. Urticaria is predicated upon abnormal reaction to acety-

icholine secreted in the blood.

ests to detect sources of allergy

Few of us would be aware if the ource of trouble is actually growing our backyard. It is important to now the offending plants even if it not practical to get rid of them. ests to detect causative agents nvolve exposing the person to a ariety of substances under controlled onditions, simulating as far as possile the natural mode of contact with nem. Since it can be dangerous to thale a sample of each suspected ollen, in practice their solutions or xtracts are applied to the skin (on ne hand or the back) through small cratches or by hypodermic injections. dedness, increase in size of wheal rea, itching and pain indicate hyperensitivity to the particular pollen.

reatment

Anthistamine drugs control most f the manifestations of allergy, neluding those of pollinosis. Cortione and ACTH, hormones derived om adrenal cortex and the pituitry, iscovered by Philip S. Hench and dward C. Kendall (1949) at Mayo linic, U.S.A., are effective for mergencies, but the relief is temporary and frequent usage leads to indesirable suppression of the body's win capacity to resist infection.

A more promising treatment nvolves hyposensitization through a eries of injections of small doses of pecific, causative allergens. Sterile extracts of the specific pollen are prepared and administered at intervals of one to four weeks. The quantity is increased gradually so that the body develops a reasonable level of tolerance (immunity) against these substances. In India such immnnotherapy is available at Patel Chest Institute, Delhi, K.G.'s Medical College, Lucknow and a couple of other centres which test the patients specifically for their reaction to pollen of plants growing in the regions. surrounding scientists at All India Institute of Medical Sciences, New Delhi, have designed synthetic filters which can' be inserted in the nostrils without discomfort and would purge the inhaled air of pollen grains or other such particles. This should go a long way in alleviating pollen-caused allergies, particularly among the aged who often do not respond much to immunotherapy.

It needs to be ascertained, if the ancient Indian practice of applying ghee to the nasal mucosa as a precaution or care against bronch'al illness actually prevents hydration of pollen or renders the mucous membrane impermeable to exuded proteins.

A.K. BHATNAGAR

Department of Botany

Hans Raj College

University of Delhi

Delhi 110007

flavour. Food prepared from vegetarian meat tastes so similar to the food from natural ones that becomes difficult for the commo man to distinguish one from the other.

Every year millions of tonnes of high protein food in the form o soybeans, peanuts oilseeds like rape seeds, cotton seeds, sunflowe seeds is used as animal feed and fertilisers. Some food experts think that these protein-rich vegetable products can be directly utilised fo making vegetarian meat. These pro tein materials, particularly soybean can be converted into monofilament as fine as silk thread. After addition of requisite flavours and colours it can be converted into imitation meat products.

Soybean based foods, specially vegetarian meat, look so appealing in today's protein-short world that i number of projects are underway for utilising soybean into a variety of products in America and othe countries. Dr. A. D. Odell of the General Mills Inc., Kankakee Illinois (one of the American companies investigating the marke of soybean based imitation meat) is of the opinion that natural steal produced by feeding animals with soybean meal is only seven per cen efficient while soybean meal consum cd directly by its conversion into artificial meat is 70 per cent.

In 1971, meat from soybear protein and flavoured wheat was served at a luncheon party at the Medical School of the University of Alabama, U.S.A., in the form of chicken salad, turkey, smoked bees sandwiches, spiced meat loaf an sausage. Food experts and medicate personnel who attended the part felt that as a food the vegetariate meat was almost a perfect imitation of natural meat in taste, consistency, chewability and smell. On advantage of vegetarian mea

Vegetable meat

THE world meat supply is miserably less than the demand. cientists have now developed mehods which have yielded highly alatable and flavoured artificial meat from vegetable sources. This meat is known as vegetarian or artificial meat.

Vegetarian meat tastes much like natural meat and possesses similar according to Dr. Vic Forelicher of U.S.A. who arranged this luncheon, lies in its low saturated fat and cholesterol content which is highly beneficial to persons suffering from heart diseases and high blood pressure.

Vegetarian or plant meat is of two kinds, i.e., meat extenders and meat analogues. Meat extenders are largely produced as flours and grits. Textured extenders are also nowadays available and used extensively in chopped and minced form to produce frankfurters. Soybean extenders added to natural meat hamburgers make it more palatable.

Meat analogues are produced to substitute natural meat. They are usually prepared from vegetable proteins to resemble specific meat texture, flavour, taste, tenderness and chewability and to imitate chicken and turkey meat, beef, bacon, bitty, etc. In Japan, vegetarian meat from soybean, both in the form of extenders and analogues, finds wide use. Their production in 1971 was about 27,700 tons, double of 1968 production.

Meat analogues are prepared from soybean filaments. Oil free soybean meal having protein content as high as 55 per cent is first dissolved and forced through fine orifice of a machine designed to spin rayon fibres. This process gives rise to fine colourless and odourless soybean fibres which are cut into suitable sizes and combined with other ingredients ike meat flavour and colour to mitate pork, ham, chicken and other meat products.

One problem that is facing the ynthetic meat market is the rising rices of soybean. To overcome this roblem, other suitable substitutes if soybean are under study. Cotton eed flour and rape seed flour are eing studied for their possible use in lace of soybean flour. They are

rich in protein content and there is no reason why they cannot substitute soybean in the preparation of meat analogues. However, they have one major drawback. Cotton seed flour contains one toxin glossypol, castor seed contains ricin, groundnut cake contains aflatoxin, and rape seed contains all the three. These toxins have to be removed before they are converted into meat products. Secondly, oilseed proteins are not complete proteins like those of meat, milk or egg. They are deficient in some of the essential amino acids such as lysine, methionine and tryptophane. It is necessary to fortify the vegetable proteins with essential amino acids in order to make them comparable to animal proteins.

There is yet another substitute,

i.e., alfa alfa, which is rich in pro teins and can be converted in meat analogues. Tortula yeast is as other substitute for soybean which is quite rich in protein content, (a high as 50 per cent) and is con paratively much cheaper. Imita tion meat from these sources ca compete well with soybean mea In developing countries like India vegetable meat holds a great promis as soybean, cotton and rape seed are available in plenty for mea making. Besides, many Indians wh are vegetarian may enjoy the palata bility of meat preparations withou violating their religious sentiment

GOKULANANDA MAHAPATR
Professor of Chemistr
Ravenshaw Colleg
Cuttack 3 (Orisso

Algae cause allergy

WITH increasing environmental pollution, allergic disorders in human beings are also increasing. Allergy may be caused by chemical or physical factors, or both. Among biological factors, allergy caused by pollen grains and fungal spores is well known. Recent evidences have proved that both aquatic and air borne algae may cause many types of allergic reactions in human beings.

Algae belong to a primitive group of plants, and resemble bacteria in their simplest type on one hand and on the other they show a degree of specialization which only falls short of higher plants. Some algae like giant kelps which grow in marine habitats attain a length of several hundred meters while the minutest algae may not exceed ten microns in diameter. These organisms exist under almost all conceivable habitats ranging from snow covered sur-

faces (Ancyclonema, Ankistrodesum Raphidonema, Scotiella) to almos boiling water of thermal spring (Aphanothece, Calothrix, Mustige cladus, Pleurocapsa). They dwe in sub-aerial, terrestrial and aquat habitats. Algae in general ar photosynthetic, using solar energ for their life processes, but quite few of them are heterotrophs, i.e, lac king the contrivance of trapping th solar energy (Astasia, Monas, Polyto mella, Prototheca). They occur wit other plants (Anabaena, Cycadeae (Zoochlorellar, Zo animals on other plant xanthellae) or (Coleochaete. Trentepohlia) an (Cladophora glomerata animals Some of them are even parasiti (Cephaleuros, Stromatocarpus). Whil some algae have been agriculturall and industrially exploited a feothers pose problems, particularly in water works supply lines an ther water bodies. Quite a few lgae (Aphanizomenon, Gymnodinum, dicrocystis, Nodularia) have also een shown to produce toxicity in nimals and allergy in human beings.

ir borne algae

Both terrestrial and aquatic algae ontribute to the population of ir-borne algae. The magnitude of nis contribution depends arious factors like climatic condions, topographical situation, etc. appears to be more pronounced tropical regions which have a efinite succession of hot, dry and et seasons associated with wide emperature fluctuations. In tropical ountries like India, high temperaweather ire, dry and strong inds lift up the soil with the gae crust formed on its surface. ligh temperature creates low presure zone which in turn sets up ertical air currents enriching the ir-borne algae flora. Drought and igh temperature also cause the rmation of special reproductive odies in the algae, which can easily ecome air borne and remain viable or a considerable period. Aquatic gae growing in temporary water odies also become air borne when he latter dry up.

Algae growing in permanent rater bodies like lakes, tanks and has become air borne due to wave ction and splashing and bursting f air bubbles. Air bubbles bursting at the water surface have been bund to eject micro-aglae upto a height of 13 cm to 19 cm into the air. This is further facilitated by the resence of higher concentration of microorganisms in the surface films and foam formed due to wave action. In addition, the foam when battered gainst rocks by strong waves plashes algae into the air.

Recently, work on air-borne llergenic algae has been initiated in ndia, at the Department of Respiratory Allergy and Applied Immunology of Vallabhbhai Patel Chest Institute, Delhi. Preliminary observations on the distributional pattern of air-borne algae showed preponderance of blue-green algae (Anabaena, Lyngbya, Oscillatoria, Phormidium), followed by green algae (Chlorella, Chlorococcum, Scenedesmus) and diatoms. Experiments on clinical implications of these algae are in progress.

Causes of allergy

As early as 1644, Johann Baptiste van Helmont, a doctor and chemist of Brabant, recognised the importance of certain 'air borne particles' in causing asthmatic attacks. Since then people have been increasingly realising the importance of the quality of inhaled air in human health. Pollen grains and moulds are well known to cause human allergy. In 1866, J.H. Salisbury, an American scientist, identified algae borne on the air and classified them as 'disease producing algaloids'.

Algal intoxication in animals was first reported in 1878 by G. Francis of Australia. He observed the presence of a fast death factor in a blue-green algae Nodularia spumigera, which caused unconsciousness and rigid spasm in sheep, horses, dogs and pigs. This was followed by a report in 1887 from E.D. Porter of USA that ingestion of another bluegreen algae Gloeotrichia pisum caused instantaneous death to cattle. Mortality in cattle has been reported when these animals drank water with a profuse growth of Aphanizomenon flos-aque. Many more algae like Anabaena, Choelosphaerium, Microcystis, Nodularia, Nostoc, Oscillatoria and Rivularia, have also been shown to cause mortality in cattle and fish. The affected animals show symptoms like partial paralysis, loss of balance, hard stool covered with blood, reduced milk yield, general

weakness, and photosensitization of skin. Resides, algal forms like Bracteacoccus, Chlorella, Chlorosarcino psis, Gonyaulux, Gymnodinium, Perdinium and Prymnesium are als toxic. Members of family Oscilla toriaceae cause hay-fever like symptoms. The affected persons show blockage of nose, itching in eyes and mild asthma within three hours after swimming in a lake with a thick growth of these algae.

Contact with Anabaoena, a blue green alga, causes dermatitis. This is attributed to the phycocyanin pigment of the alga. Conjunctiviti which is also caused by algae is attributed to hydroxylamine produced by the decay of algal proteins Like blue-green algae, some green algae (Chlorella, Scenedesmus) also cause bronchial provocations is human beings.

Only recently, attempts have been made to correlate the air-born algae and respiratory-allergy is human beings. Algae like Anabaena Dispora, Microcystis, Oscillatoria and Schizothrix, isolated from hous dust samples were subjected to cli nical tests by Carlos Benaim-Pinte of Venezuela in 1972 and enough evi dences were collected to implicat these forms in respiratory allerg in human beings. Respiratory dis orders in human beings are cause by both living and non-living alga cells. Algae have been found to cause dyspnea, cyanosis, wheezing choking, foamy nasal discharge and simple pulmonary congestion to pul monary oedema. In children, inha lant allergy is caused by the algaforms like Bracteacoccus, Chlorosar cinopsis, Hormidium and Neochloris

The allergic reactions caused be different forms can be broadle grouped into following categories:

- (i) Gastrointestinal. Vomiting
- (ii) Hepatic. Jaundice, photosensi tization of skin, and hepatospleno

megaly with varying degrees of necrosis.

- (iii) Neuromuscular. Spasms, twitching and convulsions, weakness, ncoordination and paralysis, and ethargy.
- (iv) Respiratory. Mild to severe lyspnea, cyanosis, choking, wheezng, foamy discharge from nostrils achypnes, coughing, salivation, pul-

monary oedema, potechial and gross hemorrhages in the parenchyama and alveoli.

(v) Cardio-vascular. Weak and rapid pulse, flaccid and dilated, heart and pallor and vasospasm of ears.

S.K. GOEL Division of Microbiology Indian Agricultural Research Institute New Delhi-110012 preventive measures. This is als necessary for conservation of tho species of sharks which are not harn ful to man. The following are in portant species of sharks known t attack human beings and cause s rious injuries or even death.

Charcharodon charcharias (Fig. 1 This is known as the 'white shar and is the most dangerous. It has bee known to follow ships and is the dread of sailors. It attacks on th slightest provocation. This species not represented in our coast waters. It is generally found in th open ocean of tropical countries in cluding India. Some members belong ing to the genus Charcharias found i Indian coastal waters are dangerou

Charcharias melanopterus (Fig.) recorded from coastal waters Bombay grows more than 3 m i length.

Charcharias gangeticus. The India sea shark is very aggressive and ha been known to attack bathers in th Hooghly at Calcutta. It has als been recorded from Bombay though not common in Bombay water Rarely the shark has been know to have carried away its victim (Fig. 3). Some scientists are of the opinion that the shark (C. gangeticus may have acquired the habit of eatin the flesh of corpses thrown into the Ganges after partial burning. Th sharks have acquired the taste for buman flesh and have turned int man eaters.

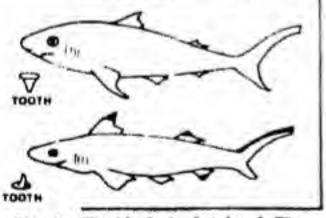
Galaeocerda cuvieri also known a the 'Tiger shark', has been recorde from Sasson Dock, Bombay. attains a length of 1.5m. A voraciou scavenger, it is known to attack me in shallow waters. The peculiar struc ture of tooth of this shark makes th identification easy in case any toot mark is left on the body of the victim

The blue shark (Prionace glauce is another aggressive shark know to attack men in Australian water

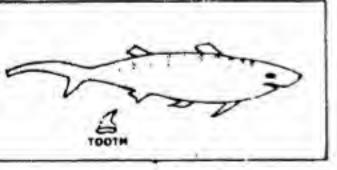
(Continued on page 36)

Killer sharks in Indian seas

OSSES of lives at sea are often attributed to shark attacks. Though some species of sharks are mown to be killers, quite a few are mall, and rarely cause serious inuries to man. Three species of



The black shark (above). The Fig. 1. white shark (below)



Flg. 2. The tiger shark

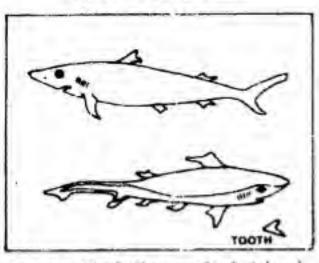


Fig. 3. The Indian sea shark (above). The blue shark (below)

sharks which grow to a large size, from 4.5-15 meters are considered harmless to human beings. They are the whale shark (Rhynodon typus), the basking shark (Halydrus sp) and the thresher shark (Alopias vulpinus). The whale shark is the biggest living fish and grows to a length of more than 12 m. It feeds on the planktons by filtering them out of the water through the gill rakers.

In India, there have occasionally been reports of loss of human lives owing to shark attack. Francis Day (1878) reported a case of shark attack brought to the hospital of Sir Joseph Fayer at Calcutta. The shark responsible for attack was the Indian sea shark (Charcharias gangeticus). The victim received serious injuries on his legs. A shark caught off Versova, Bombay, in 1973, showed human skeletal remains when the stomach was cut open in the market. Species identification of the shark was not established possibly because of its quick disposal. During the monsoon months of 1974 there was a report of loss of life of a fisherman who ventured out into the open sea during this period. The incident took place off Aleppy coast in Kerala. In this case also, there was no identification of the species responsible for the attack. Correct identification of sharks is important for



mony indicated that (i) babies born in the community—to all residents, not just to wives of the workers involved-were more likely to have birth defects affecting central nervous system; the number of such cases was almost three times the normal proportion, (ii) wives of the workers involved were more likely to have miscarriages, and the number of

exposed to it. Dr. Wagoner's testi-

brain tumours developing in adults in the towns was three times the normal level, and (iii) the incidence of cancer in PVC workers was 49% higher than normal upto 10 years, after exposure to the chemical and the proportion grew to 64% higher than normal after 15 years.

BHAKTI DATIA

Polyvinyl chloride and birth defects

'N a recent senate hearing on carcinogenic chemicals in Los ngeles, Dr. Joseph Wagoner, irector of Field Studies of the U.S. lational Institute of Occupational afety and Health, linked polyvinyl hloride (PVC) to birth defects. eccording to his testimony, birth efects were up to three times higher han normal among babies born in hree Ohio towns where PVC, a lastic material, is manufactured. t may be mentioned that PVC has lready been identified as a possible ause of liver cancer among workers

Environment engineering —third national convention-1977

TNSTITUTION of Public Health Engineers, India in collaboration with National Environmental Engineering Research Institute, Indian Standards Institution, Deptt. of Science and Technology, National Committee on Environmental Planning of Coordination, Central Public Health Environmental Engineering Organisation, Water Pollution Control Board and other similar organisations is sponsoring the 3rd National Convention on Environ-

mental Engineering which will be held sometime during January-February 1977. The venue is still to be decided. The topic of discussions will be Water Quality Management. The last date for submission of papers is Sept. 1, 1976.

For details, please write to Shri S.K. Neogi, Secretary-General, Institution of Public Health Engineers, India, 24, Netaji Subhas Road, Calcutta 700001.

SCIENCE SPECTRUM (Continued from page 366)

his species is present in the Indian in these countries. With the develop- attack banded sea snakes. On the ocean also. It is difficult to predict he environmental conditions which induce sharks to attack man. Most of the recorded shark attacks are in tropical and subtropical sess. Turoid water is considered more dangerous than clear water.

There have not been many cases of shark attacks in Indian waters, much less than what has been reported from Australia or the United States. The reason may be that bathing resorts which attract huge

ment of tourism in India bathing resorts are likely to attract huge crowds. There is then the possibility that shark attacks on unwary bathers may increase in India. In other countries measures such as lookout towers and meshing of beaches have been provided. Application of shark repellent chemicals, such as copper acetate, has been advised. Recently wearing of stilped garments has been advocated. This is based on the fact that

t is yet to be investigated whether crowds are not as popular in India as sharks have seldom been known to preventive side, meshing is the bes method for protection from shar attacks. Sharks forcing their wa through the mesh are unable to ge out and are caught. The tidal inf uence and corrosive nature of th sea water make frequent replace ments of the meshing necessary.

> M. ARVINDAKSHA Marine Biology Divi Marine Fisheries Research Sub-Station, Bombo



A new approach to cancer chemotherapy

A LL anti-cancer drugs suffer from the disadvantage of not being pecific towards cancer cells. Recent udies on cancer immunology reveal nat there are some antigenic differnces between normal and cancer ells. The antigens, called tumor pecific antigens (TSA), are known to e present on the tumor cell surface. intibodies (immunoglobulins) to SA have also been reported, but ue to the weak antigenic nature f TSA they fail to evole suffiient immune response which may ad to the death of specific tumor ell. Seeing the advantage of the nmunological specificity of the amor antibodies, it is hoped nat one could accurately deliver ome existing potent anti-cancer rug to the tumor site after tagging em to specific antibodies. n approach which dates back to a ouple of decades and was used to estroy tumor grafts with labelled ntibodies, although the basic tenets f cancer immunology were learly known at that time.

The principle of affinity cytotoicity (killing the cancer cells specically) to tumors depends upon the ffinity of the drug-antibody conjuates (combination of the drug with the antibody imparts specificity towards a particular variety of cancer cells) for the cancer cells. This can be brought into practice by the judicious use of any of the four methods, viz., (a) direct toxicity, (b) antigenic alteration to augment the immune response, (c) stimulation of cytotoxin (drug) uptake, and (d) enzyme amplified toxicity.

By appropriate techniques, nitrogen mustard (a group of anti-cancer agents) can be linked to antibody. Antibody-bound nitrogen mustard is an example of direct toxicity. It has been established that proteins and polyamino acid bound nitrogen mustard exhibit cytotoxicity towards tumer cells (Nature, 215, 1303 1967). Furthermore, nitrogen mustardantibody conjugates (a chemical complex of the drug and antibody) are capable of combining permanently with the surface elements of the cancer ce.ls. T. Ghosh of the Faculty of Medicine, Dalhousie University, Canada (Br. Med. J., 3, 495, 1972; Cancer, 29, 1398, 1972) and also other investigators (Eur. J. Cancer, 9, 741, 1973) have reported that cholrambucil (an anti-cancer drug) and antibody in combination produced improved anti-tumor effect. This increased anti-tumor response may be attributed to the individual lethal effect of the drug and antibody or it may be due to the additive effect of both. It is also possible that the drug and antibody help each other in exhibiting increased lethal effect towards cancer cells even when they are given separately. However, major efforts have been in progress towards the preparation of stable drug-antibody conjugates in recent years. Evidence of in vivo tumor suppression with covalent conjugates (chemical complex linked by covalent bond) of rabbit antitumor immunoglobulins (Ig) and an alkylating agent has been recently reported (Proc. Second National Congress of Oncology, Bucharest, 1975).

A significant development in

this direction has recently been man by G.F. Rowland and his associate of the Searle Research Laboratorie Buckinghamshire, U.K. Overcomin the earlier problems, they hav used an intermediate carrier molecul (an inert chemical used to link th drug) to heavily substitute it with th drug. This drug-carrier complex wa then linked with the immunoglobulin (Nature, 255, 487, 1975). Since poly cations (polymer with a net positiv charge) are toxic, a polyanion (poly mer of glutamic acid having a ne negative charge)-poly L-a-gluta mic acid (PGA) of molecular weigh 35,000 was chosen as the intermediat p-phenylenediamin carrier and mustard (PDM) with its free amine group was selected as the drug They were then linked by means of The suitable chemical reaction. PDM-FGA conjugate was furthe coupled to immunoglobulins from a rabbit antiserum against mous lympho na cells (EL4)-made specific by repeated absorption with norma mouse spleen cells. The linkage was induced by a carbodiimide reaction between free carboxyl group on the drug carrier (PGA) and amino acid group of the antibody.

The PDM-PGA-Ig complex was now subjected to in vitro tests. The results indicated that 66% of the original anti-EL 4 activity was retained in the complex with no loss of the specificity. The in vivo tests also showed that percentage survivals increased almost 100% (for a period of 60 days).

Thinking of human tumors, the major drawback to the use of animal Ig is its immunogenicity (capable of producing antibody against animal Ig in human) in spite of some of its theoretical advantages. On the other hand, if a drug is conjugated covalently to human antibody, there will eventually be antibody formation to the drug or to the altered antibody molecule. Therefore, the time period in which a drugantibody conjugate could be effective is limited to not more than 10-14

ays. In view of this restriction, he drug molecules which act apidly to produce lysis of tumor ells are highly desirable. Further tudies in this direction are imperative to obtain drug-antibody conjugates of high clinical potentiality.

PURABI RANI MITRA SANDIP NARAYAN SINHA Department of Biochemistry University College of Science University of Calcutta

possible economically to remove the outer husk of cereal grain kernel and with it the fiber, to produce a refined white flour. Thereafter the fiber intake has been plummeting and the present intake varies. It would be about one tenth of what it used to be in olden days. Corresponding with the decrease in the intake of fiber, the incidence of many diseases has shot up. Appendicitis, for example, became common only in this century; hiatus hernia, only in the last 30 years and coronary heart disease was considered a rarity 50 years ago. Rural Africans living on native unrefined diets do get infections, but eating unrefined cercal as a staple food they get about 25 grams of fiber a day, many times more then the average westerner gets and they are rarely afflicted by western diseases. Only recently this was recognized, partly by the work of a group of workers led by Denis Burkitt, a surgeon famed for his descovery and cure of childhood cancer named after him; Burkit

Lymphoma. Though cancer of the color has become a scourge in western countries the second most common cause of cancer deaths, after lung cancer, cancer of the colon is ran in East Africa. Annually, in the U.S. about 300,000 appendixes are remov ed, but in African villagers appendi citis is virtually non-existant. Diven tricular disease-abnormal outpou chings of the colon that can caus severe pain and may require surgeryis present in over one-third of Ameri can and other westerners above 40 years age but it appears to b absent in Africans. To prove this further, the investigators note that as some Africans adopte the western low-fiber diets, the inc dence of western diseases ros sharply. For example, the appended tomy rate increased more than 2 times between 1952 and 1969, and i

Vitamin C prevents rabies

R ABIES, a dreadful viral disease, is caused by the bite of a varity of animals: dogs, foxes, jackals, volves, mongoose, bats, etc. Dog is he most common culprit for spreading this infection. If a person oitten by a rabid dog is not treated mmediately, the disease sets in. The human victim shows symptoms of acute encephalitis and dies. The victim experiences a painful spasm when he sees water. That explains why this disease was once called hydrophobia.

Though an effective vaccine has been developed against this disease, cases of deaths due to rabies are not uncommon. Deaths occur due to not taking the full course of vaccination after dog bite.

The useful effects of vitamin C in developing body resistance to cold and in tissue healing are wellknown. In recent years interest in the virucidal (virus killing) activity of vitamin C has grown. Its effectiveness in the therapy of measles and mumps is also receiving attention of scientists. S. Banic of the Institute of Microbiology, Ljubljana, Yugoslavia (Nature, Nov. 13, 1975) has reported the preventive effect of vitamin C in rables infection. In his experiments conducted on guinca pigs he has shown that rabies-infected guinea pigs when treated with vitamin C survived in larger numbers than those which received no vitamin C. However, vitamin C did not have any therapeutic effect because continued treatment of paralysed animals did not help.

ZAKA IMAM

Correct constipation with roughage

M EDICAL developments of pervading importance which can greatly influence the health of humans are rare. Such a development could be the discovery that something missing from our diet is related to a wide variety of health problems, viz., cancer of the colon, constipation, irritable colon, appendicitis, diventricular disease, hemorrhoids, hiatus hernia, varicose veins,

obesity and possible coronary heart disease. The missing ingredient, dietary fiber, called "bulk or roughage," hardly sounds capable of being of such great importance.

Until recently, man ate much fiber, which is the indigestible part of plant cell walls present in large amounts in grains and cereals. About the turn of the century, the invention of modern roller mills made it

956 came the first case of coronary neart disease, reported in East Africa, in a 48 year old judge who had lived for 20 years on western diet.

How does the fiber act?

Fibrous food adds bulk. In the ntestinal tract they absorb water and swell making the stools soft and arge. This in turn prevents constipaion with its characteristically small, hard, pebbly, slow-moving stools. Native African stools weigh as nuch as four times those of westerners. Constipation is more than nuisance, as it leads to straining which, in turn, leads to a series of problems. Straining raises pressure n the colon, causing the outpouthing of diventricular diseases. In ddition intra-abdominal pressure also raised, which may push the tomach up through the diaphragm ausing hiatus hernia, with its neart burn, regurgitation of stomach, cid back-up into the esophagus, ind burning pain in back of the reastbone. Raised pressure in he abdomen also can be readily ransmitted to the leg veins, and to eins in the anal regions, causing emorrhoids.

ancer and roughage

Cancer of the colon is thought to esult from carcinogenic chemicals produced by bacteria in the bowel. With small, hard, constipated stools, he bacteria have more time to act, hereby concentrating the carcinoens in the small stools and retainng them for longer periods on the ining of the colon where they act. Coronary heart disease, a foreruner of heart attacks may be related eartly to the reduction of fiber in he diet. People on high-fiber iets have lower blood cholesterol evels and less cholesterol deposits the coronory arteries supplying he heart. There is enough evidence show that restoring the fiber to

diet can achieve remarkable results.

In a study of adults and children, the substitution with just two slices of fiber-rich wholemeal bread for the same amount of white bread and the addition of about 5oz of fiber-rich bran a day led, within three weeks, to marked increase in stool weight and speed-up of transit time, with an end to constipation. Many hemorrhoid sufferers have been relieved as stools have softened and straining has been eliminated.

A few years ago, roughage was banned for people with diventricular disease as it was thought to be irritating. This has been revised. In a recent study about 90 per cent of patients improved with the inclusion of fiber in their diet. Many who had been scheduled for surgery no longer required it. Similarly irritable colon has responded favourably to a highfiber diet according to British studies. Long term studies to find out the exact amount of dietary fiber required for several problems are underway, but there is evidence that it is useful in combating obesity. Since fiber in the diet has to be chewed, it slows intake of food and as well limits it by increasing the secretion of both saliva and gastric juice that serve to distend the stomach and produce satiety.

Weight reducing. Dr. K. Heaton, doing pioncering studies on fiber and obesity, has observed losses of 4.5 kg, 6.75 kg or more in persons, who simply restored fiber to the diets, without paying any attentio to either calories or to restrict foo intake.

Mode of fibre usage in food This can be achieved in several way. One is to use bran, the fiber-ric material removed, when flour milled. One can use naturall fiber rich cereals, such as oatmea Hand pound rice can be used, instea of machine-polished rice as in olde days. Seeds such as sesame, sur flower and some berries do provid fiber.

Sources of fiber. A recent study of more than 20 fruits and vegeta bles indicated them to be valuable for fiber content in the order: mange carrot, apple, brussel sprouts, brinja cabbage, orange, pear, green beans lettuce, pea, onion, celery, cucumber tomato, cauliflower, banana, potati and turnip. As much as possible fruit skins should be eaten for their fiber content. It is important to not that although bran helps, it is not the answer to the whole fiber deficiency problem.

Full benefits of fiber accrue no from just taking some bran one or twice a day, but rather from eating more foods with fiber intaction in wholegrain cereals, wholemest breads, fruits and vegetables.

R. RAGHUNATHAI Research Associat M. Medical Colleg Nashville, Tennessee (U.S.A.

Bacterial pathogenicity

I NVASION, aggressiveness and toxicity are the characteristics of bacterial pathogenicity. Bacterial diseases are manifested by local inflammatory and/or general toxic reactions. Some pathogenic bacteria elaborate potent toxins which damage the specific tissues of the sus-

ceptible host. For many of these bacteria the nature of the toxing protein and/or polysaccharide with or without lipid, and their effect on the host tissues, have been established. But the knowledge is in complete to explain the inflammator and tissue damaging mechanism of

the infective process.

Recently, pathogenicity of Vibrio cholerae has been explained on the physico-chemical property of its two metabolites - mucoprotein and/or mucopolysaccharide, and non-ionic ammonia (NH_a°). These bolites by their easy diffusibility and ion binding capacity establish osmotic differences between the adjacent tissue components of the small intestine causing abnormal water and electrolyte movement through the gut wall into its lumen. On this basis pathogenicity of some bacteria can be explained. Bacteria may produce extracellular slime material which can have toxic and immunogenic properties. Slime materials are chemically mucopolysaccharides and/ or mucoproteins. Toxins of some bacteria are also considered mucopolysaccharides in nature. Such mucopolysaccharides or mucopoly-

saccharides-mucoprotein complexes possess the cation binding capacity. It is probable that under optimal conditions these macromolecular substances pass into the body to reach the specific tissue sites where they bind with cations. Osmotic differences are thus established in the tissue. Consequently, the waterelectrolyte balance of the tissue cells is disturbed resulting in their disintegration. Depending upon degree of damage, physiological function of the tissues is impaired. This cytotoxic activity, along with the chemotactic, pyrogenic, immunogenic and lethal properties of mucopolysaccharides can satisfactorily explain the pathogenesis of bacterial Therapeutic adminisdiscuses. tration of fluids and electrolytes to toxaemic patients not only maintains the water-electrolyte balance of the tissues, but probably also provides

sufficient ions for mucopolysaccha ride absorption in order to conserve tissue ions.

The role of mucopolysaccharides in the maintenance of water-electrolyte balance inside the tissue spaces and serous cavities is well-known. Their role in the propagation of nerve impulses through participation in ionic transfer and regulation of water and inorganic ion metabolism has also been claimed. That at least some bacterial are chemically toxins mucopolysaccharides and/or mucoproteins, the above hypothesis can successfully explain the bacterial pathogenicity.

K.N. NEOGY Associate Professor & Head (Retired) Deptt. of Bacteriology School of Tropical Medicine Calcutta-700012

Cardiac output

TOW much blood a human heart I pumps in the life span of a nan was discussed by two authors in pril 1976 issue of Science Reporter. Dr. T.S. Gill on page 238 has menioned that a human heart pumps early 335,000 tons of blood in 70 ears. Shri S.L. Saha on page 253 as said it is 150,000 tons in 60 ears. Dr. Gill has written to us hat he has taken the data from the ext Book of Physiology by W. W. uttle and B. A. Schottelius, p. 244 foot note). Shri Saha quotes dodern Human Physiology, p. 357, y Dr. Chakraborty, New Book tall, Calcutta. He also refers to the

book by Boris Sergeer, MIR Publication, Moscow, (p. 137), which reads that "during a life span our heart pumps 150 to 250 thousand tons of blood."

The variation in figures given by two authors can be explained. The number of heart beats per minute generally is 70-72. The amount of blood pumped out from a human heart varies from 60 to 110 ml per heart beat. Taking the different variable figures such as heart beat per minute as 70 or 72, and the cardiac output as 60 or 110 ml we get different figures for the total amount of blood pumped by heart in 60 or 70

years. Taking heart beat per minute as 72 and cardiac output as 110 ml per beat, the blood pumped out by the heart during 60 and 70 years of life span amounts to about 267,420 tons and 312,091 tons respectively. Similarly, taking heart beat as 70 per minute and cardiac output as 70 ml per beat the approximate quantity of blood works out at 195,000 tons in 70 years.

The figures given by Gill and Saha are therefore within the range but not matched to the parameters such as heart beat per minute, cardiac output per heart beat and the life span for which these figures are given.



How headlights of a vehicle work

Have you ever seen the blinking lights of a vehicle on a highway? Or, have you been blinded by the glaring headlights of a passing vehicle? Only on occasions the vehicular lights appear to blink or glare; the lights, otherwise, appear normal to eyes.

Is there any correlation between the blinking, glaring and the visionpower of the headlights? There is a correlation—it is the special make of these lights. The parts, viz., the bulb

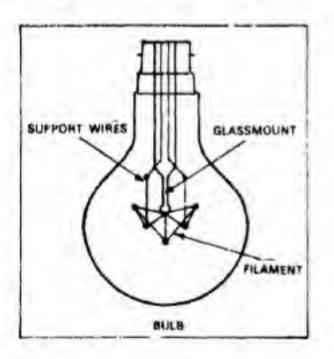


Fig. 1

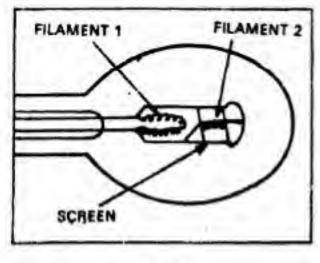


Fig. 3

and the reflector, used in it need some understanding.

We know how an ordinary incandescent bulb works. It is a glass bulb evacuated of air, filled with a neutral gas or a gaseous mixture of nitrogen and argon at a low pressure. Inside the bulb there is a glass mount on which is fixed a coiled filament supported by thick wires (Fig. 1). The filament is made of tungsten which has a high melting point and so can bear a temperature upto 3000°C. It is connected to an external circuit via two lead-in wires. They denote the two points of bulb which are in connection with the external circuit when the bulb is inserted in a socket (of screw-type or two-pin type).

The property of a concave reflector found in a headlight is to focus light, and vice versa. For instance, if a beam of light paralled to its axis [Fig.2(a)] is incident upon it, all the rays converge to one point on its axis called focus. However, convergence on a point is an ideal case. In practice, all rays do not arrive at the focus, some fall short of it while others go beyond it. This defect is known as spherical aberration. It arises because light is incident at a slightly different angle for every zone of the reflector. To eliminate this defect, a paraboloid reflector, shown in Fig. 2 (b), which converges the rays to a single point is utilised. It is so shaped that for its every zone, the light parallel to its axis is incident at the same angle. The converse of focussing is also

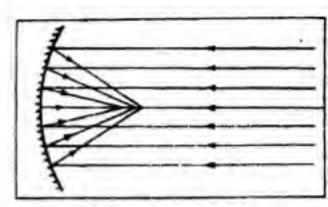


Fig. 2(a)

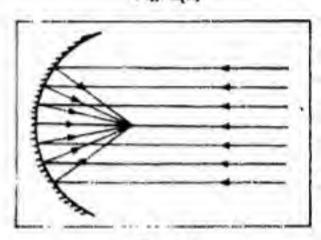


Fig. 2(b)

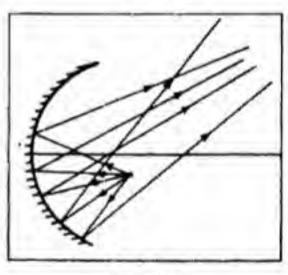
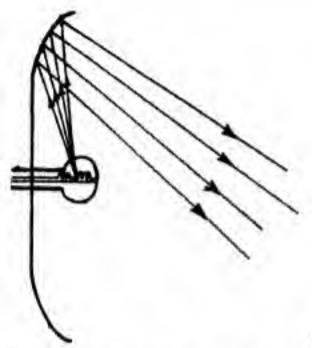
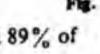


Fig. 2(c)

true: that a point of light placed at the focus of a paraboloid mirror turned into a beam of parallel light rays. If, in case, the point source of light is placed slightly away from the focus, the reflected light rays will not be parallel to each other [Fig. 2 (c)] the light beam would be scattered and the intensity of the bear reduced.

In a headlight, the bulb is of a special type. It has two coils of filament each connected separately to an external circuit by means of two pair of lead-in wires. The filament 2 (Fig. 3) has a silvered screen attached. It function is to divert the entire light emitted by the filament to one side of the bulb is attached properly it socket, the plane of the screen becomes parallel to the horizontal plant and the filament I assumes the position of the focus of the paraboloi reflector. This reflector is made of steel, coated with a thin layer of steel.





luminium, to reflect almost 89% of ne light incident upon it.

When a vehicle driver has to see r ahead, he pushes a button that ghts the filament 1. Being at the cus, the reflector reflects the light a beam parallel to the axis, i.e., raight ahead. Such a beam blinds ny one on the street or the river of vehicle coming from the ne opposite direction. As this ay cause an accident, the light is sed only on lonely highways. When riving through streets in the city, driver makes use of filament 2 of ne headlight. For one thing, the lament is not at the focus of the flector, and secondly, it has a silery screen. So, the light beam is effected on to the ground directly head of the vehicle. The light does ot fall directly on eyes and appears ormal to a bystander. The headghts appear to blink when the river of the vehicle switches over from one filament to another (Fig. 4).

Another factor which a keen observer might have noticed is that whereas the headlights illuminate the front of the car as well, the light coming from a torch, similar in construction, does not illuminate its surroundings. This is because of the diffusing power of the glass used in headlights to cover the bulb. Because of its shape, the glass not only refracts the light incident upon it to various angles but also directs it forwards.

For the correct beaming of light, the bulb needs correct alignment in the socket. There always arises some difficulty in fixing a new bulb when the old one fuses. To save one from this trouble, nowadays headlights are fabricated as a unit, and so the entire unit has to be replaced when the bulb fuses.

DILIP M. SALWI

harmony there—a definite order Look at a beautiful flower. There you will also find an order in the arrangement of seeds and of petals.

Before looking at the order of the arrangements of leaves or petals is necessary to have a discussion about two important mathematical topics—Fibonacci series and the Golden ratio ϕ .

Fibonacci series

Fibonacci series goes after the name of a famous Italian mathe matician of thirteenth century. The series runs as follows:

0, 1, 1, 2, 3, 5, 8, 13, 21, 34, 55, 89... Each term of this series is obtained by adding its preceding two terms. (viz. 0+1=1, 1+1=2, 1+2=3,..... 13+21=34)

It has also other characteristics If a, b and c are three consecutive terms, the difference of a, c and b would be unity (viz., $1.3\sim2^2=1$ 5.13 $\sim8^2=1$).

Golden ratio

This ratio was known to Greek geometers about a couple of thousand years ago. If a straight line is divided internally into two segments (Fig. 1 a and b such that a:b=a+b:athe ratio a: b is called Golden ratio of. It can be shown easily that of is equal to $\sqrt{5+1}$ and its decima expansion comes out as 1.6180339 This ratio has a feature of its own. The reciprocal of of i .61803398...... \$\phi\$ is the only posi tive number that becomes its ow reciprocal by subtracting 1. A reci angle with sides' ratio same as of i known as golden rectangle, which seems to be the most pleasin rectangle to our eyes.

Mathematics in nature

F you are asked to construct a rectangle, you would draw a ectangle of any shape, but if you re asked which one is most pleasing to the eye, you will undoubtedly hoose a rectangle whose sides ratio ary from 1:1 to 1:2 or, more precisly, rom 1:1.5 to 1:1.7. If you look t your window picture frames,

you will find the same ratios. Look at the arrangement of leaves on the stock of plants. You will discover a



Fig. 1. Golden ratio-a : b or a | b : a

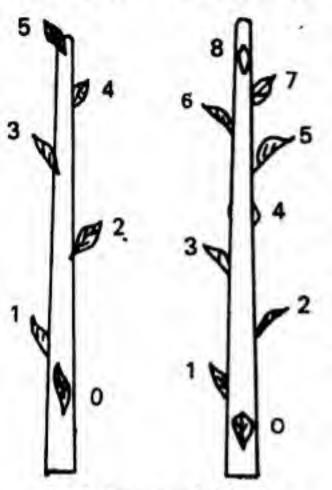


Fig. 2. Arrangement of leaves

Now let us turn our eyes to a alk of a plant—on the arrangement f leaves or buds on a stalk. Suppose e mark a leaf near the bottom of stalk, (on which there is a single af at any one point) as number 0. Ve count the leaves up the stalk ntil we come to a leaf which is irectly over the original one. Surrisingly, we will get a number which one term or the other of the ibonacci series. If we concentrate urselves in noting the number of mes we revolve (clockwise or antiockwise) about it, we would nd to our great astonishment that iese numbers are also some terms the series. If n be the number of

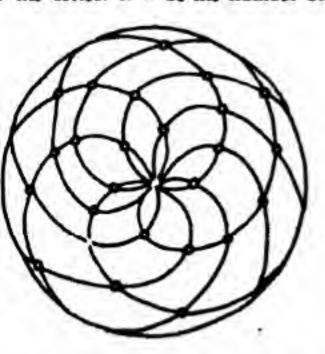


Fig. 4. Distribution of seeds in a smaller

leaves and if m be the number of revolutions in winding about the stem clockwise, it is found that n-m revolutions are necessary to reach that nth leaf in anticlockwise fashion. This arrangement is called n/m spiral arrangement. In 5/2 and 8/5 spiral arrangements the 5th and 8th leaves come just over the zeroth leaf respectively. And to reach those leaves we have to rotate 2 or 5-2 (=3) times in the first case and 5 or 8-5 (-3) times in the 2nd case. Different arrangements like 13/8 or 21/13 can be observed in a wide variety of plant growth (Fig. 2.).

Let us consider the ratio of any term of the Fibonacci series to its preceding term. The first fourteen

It is seen that both the column approach the golden ratio 4. I thin it would not be much erroneou to conclude that nature has a fasc nation for this beautiful ratio . Golden rectangle and logarithm spire

To appreciate the beauty, i.e the order and harmony in the las guage of mathematics of a flowe we have to again turn back to th golden ratio d. Poets and nature worshippers may banter at us. L us consider a rectangle, the ratio of length and breadth of which is 4 We will call it golden rectangle. we cut a square from one and th remaining rectangle would again b a golden rectangle. Figures show

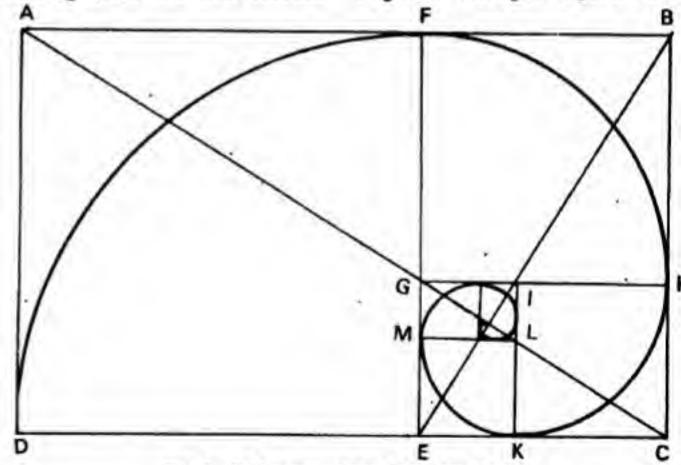


Fig. 3. Golden rectangle and logarithmic spirat

ratios can be written as:

- 1. 1/1 = 1.0000000
- 2/1 = 2.0000000
- 3. 3/2 = 1.5000000
- 4. 5/3=1.666667
- 5. 8/5 = 1.6000000
- 13/8 = 1.6250006.
- 21/13=1.615385 7.
- 8. 34/21 = 1.619048
- 9. 55/34 = 1.617647
- 10. 89/55=1.618182
- 11. 144/89=1.617978
- 233/144=1.618056 12.

13. 377/233-1.618026 610/377=1.618037 14.

the continued division of each retangle into a square and a new go den rectangle. Now if we draw circular arcs DF, FH, HK, KM, ... with E, G, I, L...as centres res pectively, we get a continuous curv DFHKM....like a spiral—we cal it logarithmic spiral. The spiral ends at a point which is the inter section of the diagonals AC and BE. The question of the curve in polar co-ordinate is &-logar, when 'a' is a constant of a particular curve The logarithmic spiral is the only type of spiral that does not alter in hape as it grows, a fact that explains thy is it so often found in nature—
the arrangement, of seeds in owers, in the shells; of snails and ther animals and even in certain uts of marbles.

Here we will discuss the arrangement of seeds in a sunflower. If we look closely at the seeds or an nlarged photograph of a flower lead we will see that the seeds are

arranged in spirals—logarithmic spirals—which coming out from the centre end in the contour, unwinding both clockwise and anticlock wise. Detailed study would show that the number (Fig.4) of clockwise spirals and the number of anticlockwise spirals are successive terms of a Fibonacci series. Here again we approach the golden ratio \$\phi\$ simply by division of these numbers.

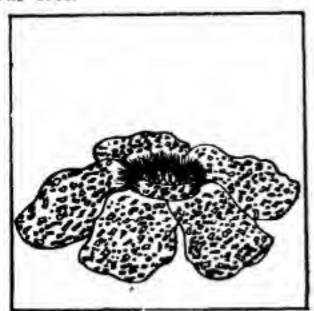
The normal head—5 to 6 inches in diameter—contains 34 spirals unwinding in one direction and 55 spirals unwinding in the other. Abnormally large heads have been grown with 144/89 combination. The ratio is 1.617978—a number which approaches very near to φ.

So much is the relation of Fibonacci series and golden ratio ϕ to nature.

DILIP K. SOM



THE African bird ostrich is the largest living bird. One bird weighs about 300 lb and is 8 ft high. It also produces the largest egg, of the size of 75 cm (without the size of the shell), weighing about 3 lb. The ostrich cannot fly, but can run at a speed of 40 m.p.h. It has only two toes while other birds possess four toes.



NOT all flowers answer poet's idea of tenderness and softness. Consider, for instance, the flowers

Of birds and plants

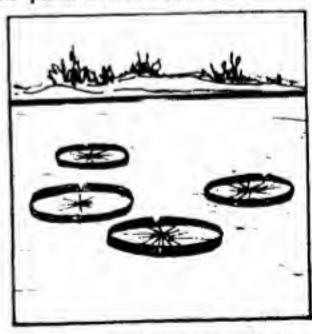
of Rafflesia. Rafflesia flowers are the largest in the world, are weighing 10 kg and are 50-70 cm in diameter. It takes about one and half years a flower bud to open, but the flowers are ephemeral and decay within 2-3 days. They smell like putrified meat. The only vegetative organ possessed by such giant size flower is a thread-like mycellial haustorium which penetrates the host's body.

Rafflesia is a root parasite and a native of Java.



THE king of the carnivorous plants, Nepenthes or pitcher plant, swallows and digests its prey in a strange manner. Leaf tips become long and develop a pitcher-like structure with a lid over the mouth. The lid is projected and edges of the pitcher are curved inwards. At the mouth of pitcher are many hairs

or honey glands pointing downwards. Insects are attracted by the smell of the honey or by the bright colour of the pitcher which may be red, yellow, purple or green. Insects slip down due to slippery inner walls into the liquid at the bottom of the pitcher. The insect cannot escape because as soon as it enters the pitcher the mouth of the pitcher is immediately closed by the lid. The plant absorbs the insect.



A plant which is native of Braziland and belongs to the lotus faimily has leaves of enormous size. Victoria regia, or the giant water lily has floating leaves which are about two meters in diameter. They loo like large dishes on which you callie down comfortably. Edges of the leaves are turned upwards to height of several centimeters.

NISHA BAJPA

Fun with geometrical figures

POPOLOGY is a new branch of geometry which has entirely een discovered in the present cenury. In it, we are concerned with ne properties of geometrical figures hich are invariant by the gradual hange in shape and size. Though includes many things and has been efined in many different ways is now generally considered as ne study of continuity. The gennetrical figures which can be drawn nd which cannot be drawn in one ontinuous move, i.e., without raiing the pencil and without traversing he same line again, follow certain ules.

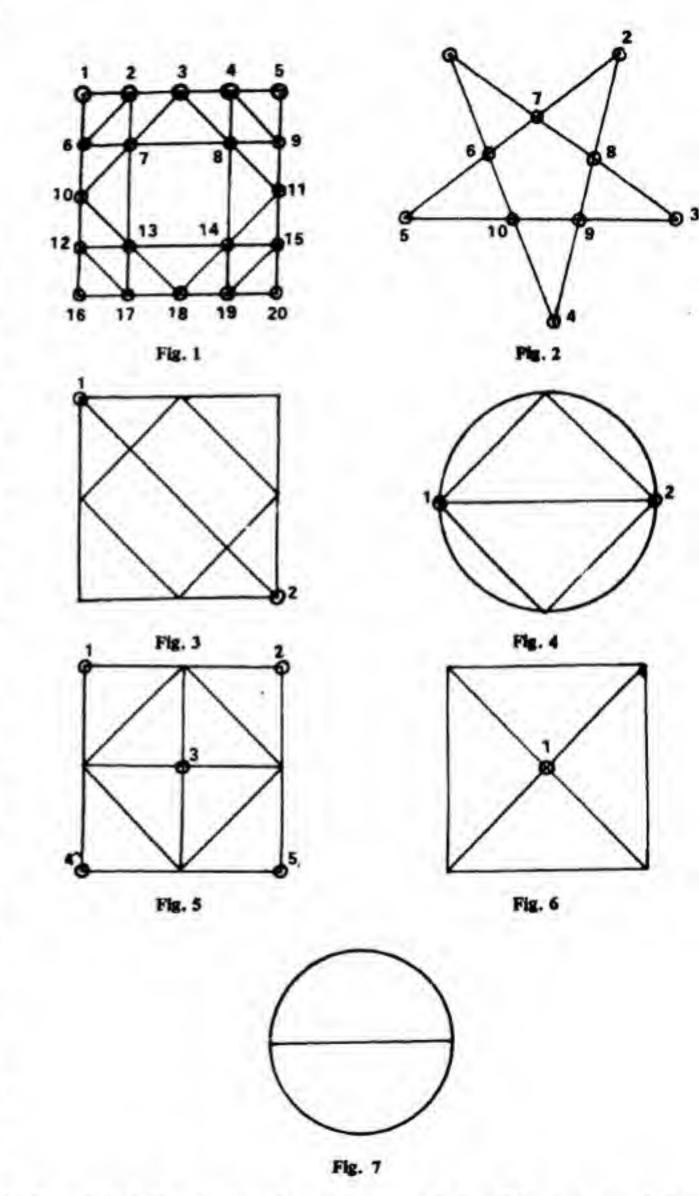
Observing Fig. 1 we find that two nes meet at vertex 1,5,16, & 20; our lines at vertex 2,3,4,6,9,10,11,-2,15,17,18 & 19 and six lines at ,8,13 and 14. Hence, we can onclude that even number of lines neet at each vertex. The same is he case in Fig. 2.

Such figures, which have all evenertices (i.e., vertices where even umber of lines meet), can be drawn n one continuous move beginning

rom any vertex.

Now consider Figs. 3 and 4 which ave only two odd-vertices 1 and 2 i.e., vertices where odd number of nes meet), other vertices being ven. Each of these figures can be rawn in one continuous move if the tart is made from any odd-vertex. t is not possible to do so if the start made from any even-vertex.

A geometrical figure may not have single odd-vertex (Figs. 1& 2), but, there are odd-vertices in it, they nust necessarily be in even numbers. In the other hand, the number of ven-vertices can be even or odd.



In Figs. 1 & 2, the number of evenvertices is even, and in Figs. 5 & 6 they are odd. There are also geometrical figures in which number of even-vertices is nil as in Fig. 1.

If the figure has odd-vertices in it, the minimum number of continuous moves required to complete it will always be less if the start is made from any odd-vertex. Moreover, if th start is made from any odd-vertex it will get completed on any other odd-vertex.

The number of odd-vertices in figure determine the minimu (Continued on page 325

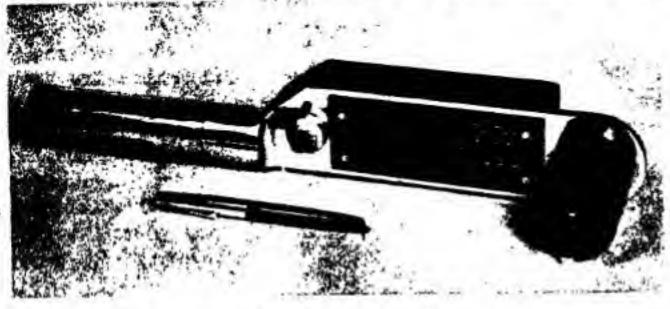


SCIENCE IN INCIDUSTRY

Electronic torque wrench

WRENCH is a mechanical device for tightening bolts in mechanical structures. With torque wrenches controlled amount of torque can be applied to bolts.

Electronic torque wrench provides higher precision than mechanical torque wrenches. This is useful in the field of aircraft fabrication, where torque control is of prime



Electronic torque wrench

Specifications

1. Range

0 - 15 kg.m.

2. Linearity cum

± 1% of rated load

hysteresis

1% of the rated load

3. Setting revolution

.

4. Operating

: 0 - 50°C

temperature

importance in ensuring the optimum performance of the structure.

In the electronic torque wrench developed at National Aeronautical Laboratory (NAL), Bangalore, the torque level is sensed through a bonded strain gauged member and the signal processed with an I.C. type signal conditioner. The device is energised by rechargeable cells having a duty cycle of 8 hours, thereby making it portable and convenient to operate in workshop. The signal conditioning unit and the cells are housed within the frame of the wrench itself.

The torque level can be foreset with the help of the graduated dial on the wrench. When the output of the signal conditioner corresponding to the applied torque attains a particular level determined by the preset, a light emitting diode on the wrench gives an indication.

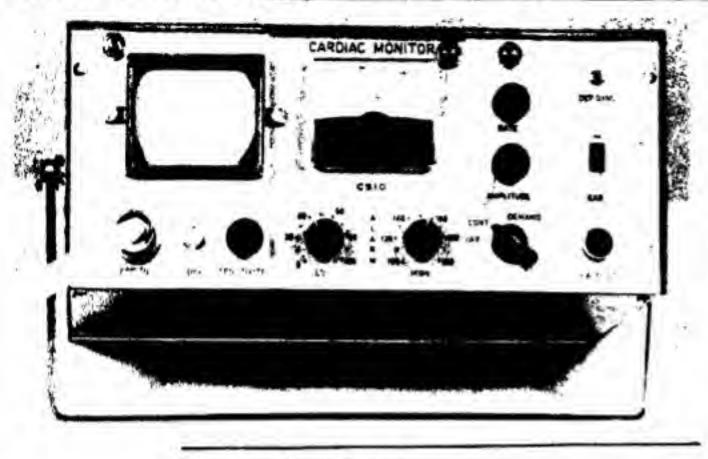
Strain gauges manufactured with the laboratory knowhow have been used in the sensing element.

Such an electronic wrench has been developed for the first time in the country.

Cardiac monitor

THE Central Scientific Instruments
Organisation, Chandigarh has
developed cardiac monitor for continous monitoring of ECG waveform
and heart rate of a patient. A pacing
unit is incorporated for stimulation
of heart in case of complete or
partial heart block.

The E.C.G. waveform is displayed on a long persistence flat-faced cathode ray tube screen and the heart rate in beats per minute on a meter.



Specifications

nput impedence CMRR (Common Mode Rejection Ratio)

Recovery time
Prequency response
Deflection sensitivity
Heart rate range
Pacemaker
Pulse amplitude
Pulse rate

10 M ohms
60000:1
(with 5 K ohms source impedence unbalance)
4 secs approx.
0.1 Hz to 250 Hz
0.5 cm per mV to 2.5 cm per mV
0-200 beats per minute
Constant current, demand, internal type
1-20 mA
50 to 150 pulse per minute

Lower and upper limits for the heart rate can be set. An audio-visual alarm gets initiated, if any deviation from the set limits occurs. Triggered sweep ensures highly readable meaningful display. One mV signal source is provided for easy calibrations. The E.C.G. signal picked up from the patient with usual E.C.G. electrodes is fed to an amplifier naving a high input impedence, a high noise rejection and protection

against high voltage counter shocks.

The pacing unit provides electrical stimulation to the heart when intrinsic pacing of the heart fails. It can be operated non-synchronously as well. Internal electrodes are to be used for stimulation. The pacing rate and intensity can be adjusted.

Output sockets for difibrillator synchronisation and recording are provided. The instrument is portable and mains/battery operated.

Night soil digester

IN India, water carriage system is provided only for about 8 per cent of the population. Majorty of the urban, semi-urban and ural community is having dry

conservancy system where the night soil is collected from pail type of latrines. Night soil thus collected is disposed of by dumping or trenching causing in most of the cases

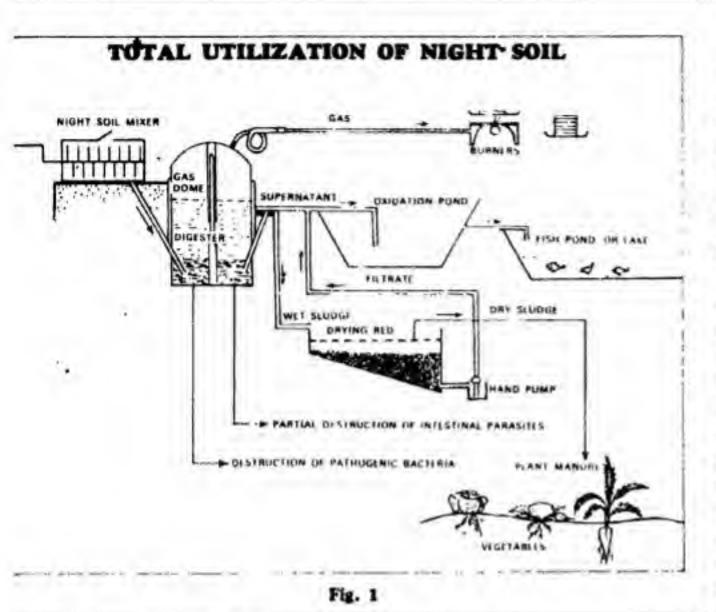
environmental pollution and sprea diseases. conservan of Dry system, though not desirable cons dering the aesthetic aspects, is like to continue in majority of villag and towns in India for the comir 2-3 decades, as the water carria, system is very expensive. The National nal Environmental Engineering R search Institute (NEERI), Nagpi took a realistic approach to the problem and conducted research on various aspects of night so digestion.

Night soil digester is a mason structure partly above and partly below the ground with a floating dome at the top to collect the gargenerated in the digester. There provision in the digester to feed night soil slurry and withdraw the digester sludge and supernatant. NEERI has fabricated a night soil digester which can be constructed and run economically for a population of 250 comore, provided the gas is utilised in the vicinity of the digester without expensive distribution system.

A demonstration night soil dige ter is put up by NEERI at the Central Prison, Nagpur, to demontrate the technique of total recyclof the human waste.

Night soil is homogenised into slurry of about 6-8 per cent total solids and fed into the digester. The organic loading in the digester is about 0.8-2.2 kg VS/m³/day depending upon the temperature of the place. Once or twice in a week the digested sludge from the night soil digester is withdrawn on to sludge drying bed, for dewatering and drying. The supernatant of the digester and the underflow of the drying beds are further treated in stablisation pond.

About 0.025 m³/capita/day of gas with 60-65 per cent methan content is produced in the digester. The gas has a calorific value of 4713 kilo calories/m³. The gas calorific



be utilised for cooking, lighting of as a motive power. The dried sludg cake (moisture content about 20 percent) is rich in nitrogen, phosphorus and potassium. It is a good organismanure and a soil conditioner. The effluent from the stabilisation pone can be profitably utilised for irrigation or pisciculture.

Night soil is a carrier of pathogenic organisms and thus indiscriminate disposal of night soil causes soil and water pollution, spreading water borne diseases. Night soil treated if the digester renders the digester dried sludge and the stabilisation pond effluent harmless to the community. The total recycle of huma waste minimises the spread of diseases and brings revenue to the community in the form of fuel-feed-fertiliser.

GENETIC ENGINEERING (Continued from page 336)

ossibly spread to the population at arge.

United States has already taken recautionary measures to safeguard esearch in genetic engineering. A high level committee, comprising leven outstanding biologists, on ecombinant DNA molecule has been formed to see guidelines for all uture genetic experiments. In a onference held last year at Pacific Grove, California, the Committee trafted the following points:

- 1. Complete stoppage of contruction of new bacterial plasmids which could carry combinations of ntibiotic resistance or toxin characeristics not found in nature (plasmids re extrachromosomal hereditary particles containing DNA).
- 2. No synthesis of recombinant nolecules containing DNA from nimal viruses particularly oncogenic r tumour causing viruses.

Taking a preventive approach, the ommittee asked for a deferal of hese two types of experiments with the greatest potential hazards.

One major and serious objection is purely biological in nature. The beauty of this world lies in the diversity of forms whether that be a plant or animal or human being. There is a great ecological impact on balancing the individual potential, in the society or habitat, due to this intrinsic and inherent diversity. Besides, the total survival value is increased to a greater extent due to this diversity and this individuality must be maintained at any cost. Indeed, there is an actual danger of wiping out completely of any 'perfect' or 'engineered' form of plant or human beings just with one stroke of environment if these turned out to be, at any stage, not in harmony. At that time, there may not be left even a single "seed" to perpetuate that very form.

So what should be done? The agonizing moral questions posed by almost all subjects of genetic engineering has divided the scientific

community. Dr. Robert Sinsheime of California institute of Technology U.S.A., is of the opinion that thos who oppose genetic engineering "ar not among the losers in the chromo somal lottery that so firmly channel our human destiny." Dr. Salvado Luria of MIT, U.S.A., a Nobel Lau reate, takes the opposite viewpoin "we must not ignore the possibilit that genetic means of controllin human heredity will become a massiv means of human degradation". I is probably unwise and perhap impossible to barricade any street o scientific enquiry. But it must b done with great awe, prudence and caution especially huma heredity.

Further reading

- Cohen, S.N., Sci. Amer., 233 24 (1975).
- Grobman, A.B., Social Implications of Biological Education
 National Association of Biology
 Washington (1970).



CHORIUM: PHYSICO-CHEMI-CAL PROPERTIES OF ITS COMPOUNDS AND ALLOYS Editor O. Kubaschewski, Special ssue No. 5, International Atomic Energy Agency, Kartner Ring, II P. D. Box 590, A-1011 Vienna, Austria, Pp. 244, US \$ 15.00 (£ 6.20; Dm 14.50)

THORIUM is of special interest to India because of its link oth the rich monozite sands which re abundantly available in the outh and in other parts of the ountry like Bihar. Thorium is btained as a byproduct of the xtraction of both rare elements from monazite sands) and uranium, nd the increasing use of these naterials will continue to keep horium production well ahead of onsumption. According to one f the authors of this monograph, he available thorium supplies are stimated at 0.5 million tonnes and aferred stock over double this mount, compared with the cumutive usage of thorium upto the ear 2000 A.D. of 40,000 to 80,000 onnes.

Discovered in 1828, thorium is istributed in the earth's crust to the extent of 15 parts per million. The otentially large use of this element reactors arises from the fact that have (the only isotope found in nature) can absorb neutrons to produce the fissile U²³² making thorium asset in a breeder reactor. It as been suggested that during this ecade high-temperature reactors fill use UC₈-Th C₈ or UO₈-Th₈ articles coated with carbon/silicon

carbide, dispersed in a graphic matrix and cooled by helium, as shown in the DRAGON, (OECD), Peach-Bottom (USA) and AVR (FRG) reactors as well as the larger 330 MW Vrain 300 MW THTR reactors.

To work on such projects and the still more complex and sophisticated reactors of the coming generation, it becomes necessary to study the characteristics of thorium in detail and in depth. This monograph like its four previous ones (on plutonium, niobium, tantalum and beryllium) attempts to meet the demand for reliable thermodynamic and kinetic data. Such critical data are not necessarily those that come closest to the true values, but rather these that produce a consistent picture of the physico-chemical properties of chemical substances. This demand pertains particularly to the thermochemical properties and related phase boundaries, which are to a large extent interdependent. Here the special issues are concerned with the critical evaluation and documentation of thermodynamic properties, densities, crystallographic structures, equilibrium diagrams and diffusion rates in the condensed states.

All the five contributors are scientists of high international standing from UK, USA, Federal Republic of Germany, Italy, and Switzerland.

As a painstaking and laborious work, this is an excellent compilation on the thermodynamic properties of thorium covered by tables, diagrams and extensive references to the data presented.

Having devoted so much time, energy and talents for this collation, an index at the end, even of a condensed nature, would have been very useful.

S. K. GHASWALA

MODERN PHYSICS (Atomic and Nuclear) by S.L. Kakani, H.B. Saxena and P.C. Jain, The Studen Book Co., Jaipur, 1975, Pp. 28 Rs. 11.50.

THE new developments in physic which have occurred in the twentieth century are usually groupe under the title modern physic. Any book which tries to present these developments, viz., relativity quantum mechanics, nuclear physics, etc., in a lucid manner is vermuch desirable, particularly so, the book is written for undergradual students. The book under review an attempt in this direction.

The book has been divided interpretations; one containing brief chapters on relativity, quantum mechanics, X-rays and lasers; the other deals mainly with nuclear and particle physics. However, there does not seem to be any logic to divide the book in such a manner applied fields like X-rays and laser should not have been bracketed with the purely theoretical chapters of special relativity and wave mechanics.

The book starts with a chapter o special relativity. The authors ex plain in a very brief manner th significant developments which too place in it. They have been able to introduce concepts like Lorent contraction in a fairly simple way It is good that they have not endea voured to include general relativity a this level. There are also a large num ber of worked-out examples which it is hoped, will definitely make th concepts of relativity clear. Th second chapter gives a brief working knowledge of quantum mechanic and deals specifically with wave particle duality, Schrodinger equa tion and uncertainty principle. The authors illustrate these concepts by working out large number of exam ples; e.g., tunnelling effect, is explai ned in detail. The next chapter or X-rays is written in the usual manner However, the chapter on lasers does give a good introduction to this extremely important and rapidly growing field. In the section B of the ook, the authors take considerable ain to present nuclear and particle hysics as much as is possible for ndergraduate students. They have een able to give brief introduction all important ideas of nuclear hysics. The chapter on particle hysics contains nice reproduction of actual photographs of the elemenary particles taken in the bubble hamber.

Despite the above mentioned shortomings, the book on the whole is
nicely written, and the authors need
to be appreciated to have presented
to much matter in such a small book.
There are a large number of unsolved
troblems which the readers can easily
tolve by taking hints from the solved
tolve by taking hints from the solved
tolve by taking hints from the solved
tolve given a good collection of
the given a good collection of
the phave rightly included important
tolve formation regarding symbols and
the subject index.

MANMOHAN GUPTA
Department of Physics & Astrophysics
University of Delhi, Delhi

LANT PHYSIOLOGY—THEORY ND PRACTICAL (2nd Ed.) by B. Mehra and S. K. Khanna, Sultan Chana & Sons, Delhi, 1974, Pp. 480, Rs. 20.00.

URS is a country where there is no dearth of mass publicaion of science books for university tudents. But, unfortunately, many of these books are written by authors who do not have the patience (to out it more correctly, it is dedicaion) to go through the current cientific literature and include hem in their text. The pre entation of the subject matter t is no better than that of a ookery book. Many of these ooks give ideas to the reader in way that it seems there is no research work going on in a particular field, and that everything on that particular aspect has been done. It is unequivocal that production, publication and distribution of such books are highly detrimental to the young mind.

The book under review, however, is free from many evils. To compile a text book on the different aspects of plant physiology is a hazardous task because of the vastness of the research going on in various aspects. However, the authors have been successful in presenting the text in a satisfactory way by including some of the current developments in various fields. The book is divided into two parts, one theory and second practical, making twenty-six chapters in total. The part dealing with theory is appreciable because of the inclusion of some extraordinary topics which are not met with in a usual plant physiology book. However, the part dealing with the practical has been dealt with in the usual way. It is high time that the Indian universities started carrying out the physiology experiments on a quantitative basis. Therefore, it is desirable that the manuals on plant physiology make a quantitative approach.

The inclusion of syllabi and previous question papers of various Indian universities have spoiled the appearance of the book as a text book. Such things are more suitable for a "guide".

Jose Kallarackal Department of Botany University of Delhi, Delhi 110007

PLANT SCIENCE by J. Janick, R. W. Schery, F.W. Woods and V. W. Ruttan, W. H. Freeman and Co (USA)(2nd Ed. 1974)Pp. 740, \$ 14.50.

THE authors have written this book collaboratively as a text

book for university courses incor porating scientific, technological and economic aspects. The two topics plant science and crop agriculture have been merged here. The bool has been divided into six parts which are further subdivided into chapter dealing with relevant topics. Par I named, Plants and Men, deals with crop plants, their production, huma needs, pollution and environmenta factors. It shows us the relation ship between crops and the civilisa tion. Part II describes the natur of crop plants, their origin, classi fication, structure, function, growth development and propagation. Par III describes the plant environment i.e., requirement of light, heat, soil water, climate and geography o crops. Part IV mentions the tech nological aspects of agricultura practices dealing with croppin system, nutrition, crop hazards and improvement of crops. Part V deal with the industry of plant agricul ture and surveys the individual cro species. The last Part VI named The Market Place, deals with the economics of crop production, dis tribution, world market, trade policy etc. It also deals with the organiza tion and management of agricul tural research systems, change in technology and economic develop ment of agriculture. Though the book is meant for a course in th American universities, it would be very helpful to students all over the world, as it is of a very informative nature. It will serve a very good reading material for those interested in world agricultural problems and achievements. The book has bee presented in a very simple languag which can be understood by non scientists also.

AJIT K. MISHR.

Professor of Microbiolog.

Bose Institute, Calcutta 70000

FIRST COURSE IN GROUP THEORY by P.B. Bhattacharya and S.K. Jain, Wiley Eastern Private Limited, New Delhi, Pp. 97, Rs. 10.

THE importance of theory of abstract groups and its utility n applications in a bewildeof ring number apparently inconnected subjects in science mathematics is now well and stablished and universally recognised. is applications appear in quantum nechanics and crystallography, in geometry and topology, in algebra, n chemistry and even in biology.

Although groups have their use a diverse fields, the study of abstract groups itself is very important. That is the reason why group theory continues to invoke considerable interest which, as the authors of the book under review point out in the preface, "is reflected from the increasingly large numer of research articles on this subject published every year".

The book under review, as justiliably claimed by the authors, is
designed for a one semester undergraduate course in group theory.
The book presupposes on the part
of the students "a knowledge of
high school algebra and geometry
and some familiarity with the elements of set theory". The latter being
not in most of the high school curicula in India, the authors have attmpted to bridge the gap by giving
small introductory, though not
ufficient, exposition of set theory
in an appendix.

Starting from rudimentary concept f groups, the authors have discused permutation groups, subgroups and cosets, normal subgroups and uotient groups, cyclic groups and lass equation in chapter I. Homonorphism, isomorphism and autonorphism are dealt in chapter II.

Structure theorem for cyclic groups and Cayley's theorem have been proved. In chapter III, starting with definitions of direct products of groups, one finds Abelian groups and finite Abelian p-groups discussed. The Sylow theorems find their place in chapter IV. These theorems occupy a significant place in the theory of finite groups. These provide us with some important properties of groups from arithmetic properties of their orders. The Jordan-Hodler theorem and solvable groups are preseted in the last chapter. The material covered appears to be largely influenced by the prominent authors on group theory like W. Ledermann, Jacobson, Marshal Hall, Carmichael and Rottman.

There are many solved problems included in each chapter, which would be helpful in understanding the subject. In addition to these, there are unsolved problems at the end of each chapter which are left to the student to work out. If the student attempts to solve these problems, it would reinforce his grasp over the subject. Equipped with the knowledge from the book under review, the student could proceed over to more advance books on group theory.

A preview at the beginning and a summary at the end of each chapter would have been of additional advantage to the student. Historical evolution of the concepts of group theory could have been briefly described at various places—in order to motivate an involvement in the subject.

A bibliography covering relevant books is an omission. Printing mistakes show up menacingly here and there.

R. KAUL

Deptt. of Physics & Astrophysics Univ. of Delhi, Delhi PRINTED CIRCUIT TROUBLE SHOOTING by H.R. Shemil Electrochemical Publications Ltd., 2 Barns Street, AYR VA7 IXI Scotland, Pp. 105.

THE broad spectrum of printe circuit applications usual means that the method of design must be tailored directly to the appl cation. A process that is used produce parts for satellites, portab radios, computers, scientific instri ments, television sets, toys an missiles must be flexible enough t meet the general standards of quali and cost of each application. An the process of printed circuitry, sing its acceptance some twenty years ag as a means of interconnection for radio and electronic devices, ha brought revolution in the electron industry.

In general, positive attributes of printed circuits lie in reduction weight as much as 10:1, space organ sation and control, cost saving b standardization and simplified of automated production with fewer material and less training of fewe people; in reliability through simple uniform assembly reducing error and connection minimization an These circuits have som control. also. Mo: negative attributes disadvantage important is th amplification of shock or vibratio inputs. In addition to their poo repairability, the thermal design of printed circuits is complicated an limited. Also, the revision of thes circuits is difficult and sometime impossible.

With the problems associate with printed circuits in mind the author presents this book, a highly specialized text on the subject of printed circuits, which deals mainly with the art of troubleshooting Nearly half of the text is in tabulation consisting of more than thirt fault charts which describe the

roblems associated with various rocesses alongwith their possible ause and the suggested remedy.

The basic initial step in the fabriation of a printed circuit board is he generation of a pattern from artwork onto a copper or other metalclad laminate. The master network cannot be used directly for printed wiring board production as it is larger than the finished board and is not sufficiently durable to withstand handling during manufacture. It is necessary, therefore, to photograph the master artwork, either as a positive or negative depending upon various factors. Thus, the book rightly starts with describing artwork and photography. In the simplest method, known as "print and etch" (Chapters 4, 5 and 6), a copper-clad laminate is coated with the exact pattern using a protective resist material. The unprotected copper areas are subsequently chemically etched to remove the unwanted copper from the laminate. The resist is removed after etching, leaving a replica of the desired pattern in copper

The plating of high quality printed circuit boards have been described in detail (Chapters 7 and 8). Copper is normally deposited on all printed wiring boards and the quality of the deposited coating is governed by a number of factors. The author, then, explains the need of gold, nickel, rhodium, silver, tin-lead, and tin-nickel plating for different requirements. However, in the fault assessment chart eleven problems associated with copper plating have been given along with their cause and suggested remedy, but the author points only two and four problems associated with gold and nickel plating, respectively. The innumerable analytical procedures available for all the electror lating and relating solutions used ir the plating of printed circuits by rds are described

in detail and the tables given at the end of the chapter on electroplating are very much useful to manufacturers.

In the production of electrical and electronic equipment, the joining of metal surface by soft soldering to produce a good mechanical bond of low electrical resistance is an essential feature of assembly processes. "The production of a reliable mechanical and electrical joint is, however, much more complicated than just bringing two surfaces together with molten solder", the author adds while describing soldering. The author further adds while discussing the problems associated with unprotected boards, or those coated with a flux preservative lacquer that, "It is unusual to carry out a soldering process on a copper surface unless the surface is freshly prepared and protected by a flux preservative coating. As the preservative is essentially a means of preventing oxidation and the soldered interface is, in fact, the surface copper, these two forms of presentation can be considered together." The author's observation is that the gold layers upto five micrometer thick can be soldered without difficulty if a limited storage time is observed and optimum soldering temperature is about 220°-240 °C. that the

The author warns control of quality must start at the design stage to ensure a minimum of rejects at the final stage of production. He therefore suggests various inspections related with the choice of material, surface appearance, dimensions, physical characteristics and solderability. In addition to these checks, the book describes numerous inpections visual as well as general. The author is critical about the multilayer printed circuits which fall into a special category for inspection purposes. He further suggests that before releasing the component, the circuit must be tested

mechanically and electrically.

In chapter 14, the new techniques have been described which eliminate many of the problems inherent in the conventional method of printed circuit manufacture. In this chapter, the author details the additive and multiwire printed wiring boards. The author is impressed with the additive technology and tabulates its advantage giving seven characteristics, eighteen functional, technical or manufacturing advantages and economic benefits. The author then describes pin -and blade connectors, programme controlles, switches, resistors transistors and diodes, and capacitors, transformers and toroids as the miscellaneous components for printed circuit board assembly.

Very interesting feature of the book is that it reviews important specifications dealing with copper-clad materials, and print and etch, plated through, and multilayer printed wiring boards. It describes specifications of the U.K., U.S.A., and International Electrochemical Commission. The chapter on terms and definitions is very interesting.

The author has made an excellant attempt to write this book which is of direct interest to all personnel involved in this hybrid technology whether they be design or production engineers, chemists, metallurgists, inspectors, or merely apprentices, trainees or process workers, as it covers all aspects of printed circuits manufacture in chronological order from the initial design stage to final inspection of the completely assembled circuit.

VIIENDER SHARMA

Microwave Laboratory

Department of Physics an

Astrophysic.

University of Delhi, Delhi-11000

ADVERTISEMENT TARIFF FOR SCIENCE REPORTER

ORDINARY POSITION

SIZE	CASUAL	CONTRACT SIX INSERTIONS	CONTRACT TWELVE	
FULL PAGE	Rs. 800.00	Rs. 4200.00	Rs. 8000.00	
HALF PAGE	Rs. 450.00	Rs. 2550.00	Rs. 5000.00	
QUARTER PAGE	Rs. 250.00	Rs. 1250.00	Rs. 2500.00	

SPECIAL POSITION

SECOND, THIRD, BACK COVER PAGE OR PAGE FACING SECOND COVER PAGE

SIZE	CASUAL	INSERTIONS	INSERTIONS & ABOV	
FULL PAGE	Rs. 1000.00	Rs. 5500.00	Rs. 10,000.00	

COLOUR: Rs. 250.00 for each additional colour.

MATERIAL: Mounted original Zinc Blocks and Layout.

TERMS

- 1. Matter is accepted upto 15th of each month for the next issue.
- 2. Additions and cancellations, if any, must reach on or before 20th.

In accordance with the latest instructions of various examining bodies and based on latest trends in examinations

FOR SURE SUCCESS

Read

Arun's Objective & Short Answer Type Questions in

1.	Physics	Rs. 4.50
2.	Chemistry	Rs. 4.50
3.	Mathematics	Rs. 4.50
4.	Biology	Rs. 4.50
5.	English	Rs. 4.50
6.	History	Rs. 4.50
7.	Economics	Rs. 4.50
8.	Commerce	Rs. 4.50
9.	General Knowledge & I.Q.	Rs. 3.00
10.	Civics	Rs 4.50

Published by:

YOUNG MAN & CO.

888 NAI SARAK, DELHI-110006

Copies available with all the leading book sellers or send your order with an advance of Rs. 5.00 by M.O.

FOR MEDICAL ENTRANCE TESTS

Read

ARUN'S GUIDE

For

EDICAL COLLEGES ENTRANCE EXAMINATION

Objective & Thought Type Questions

Containing

(FOR A.F.M.C. POONA, C.P.M.T. U.P., VARANASI, ANDHRA PRADESH, VELLORE, PONDICHERRY, BANGALORE, MYSORE, BIHAR, ORISSA, ETC.)

7th Revised Edition 1976

Price: Rs. 22.50

and

LL INDIA INSTITUTE OF MEDICAL SCIENCES

(Entrance Examination)

Containing

Short Answer & Essay Type Questions
(ALSO USEFUL FOR WEST BENGAL, ALIGARH,
M.P., WARDHA, RAJASTHAN AND MEDICAL

COLLEGES OF DELHI, ETC.)

Published by:

Price: Rs. 21.00

YOUNG MAN & CO.

888 Nai Sarak, Delhi-110006

INDISPENSIBLE BOOK

FOR

MEDICAL ADMISSION TEST OF

POONA, U.P., A.P., M.P., VELLORE, PONDI CHERRY, VARANASI, ALIGARH, BIHAR ORISSA, BANGALORE, MYSORE, ETC.

OBJECTIVE GUIDE

INCLUDING

MULTIPLE CHOICE, THOUGHT, NUMERICAL AND QUESTIONS OF VARIOUS MEDICAL TESTS

Price: Rs. 25.00

Postage: Rs. 2.00

POPULAR BOOK STORES

OPP. PATNA COLLEGE PATNA-800004

FOR SURE SUCCESS

C.P.M.T.

Read

NUMERICAL PROBLEMS
Objective Type

in PHYSICS & CHEMISTRY

Price: Rs. 6.00

2nd Revised Edition 1976

Published by

SANJAY PUSTAK MANDIR

Educational Publishers & Book Sellers, Raja Mandi, Agra 282002



every purpose

With Service & Smile Since 1935 innovating import substitutes of speciality papers.

BLACK CENTERED ART CARD CHROMO-BOARD ALSO IN REELS.

TITACHUR Safety Cheque Paper

TS.A.D. Ledger (Rag) HATHICOTE

TITACOTE TUSKER BOARDS CENTURY

BOARDS COVERS PRINTING & WRITINGS

Known as Plastic) SURUCHI ART PAPER & ART CARD MAXIGLOSS CHROMO PAPER & ART CARDS IN WHITE & ATTRACTIVE COLOURS.



ram nath a sons

2426, Chawri Bazar, Delhi-110006

Phones: 260691, 261517 Grams: 'FLYINGHORS' Telex: RNS ND 2985

PUBLIC

SCIENCE REPORTER











Re. 1.00

COUNCIL OF SCIENTIFIC & INDUSTRIAL RESEARCH NEW DELHI-110001 GRAVITATION IS STILL A RIDDLE
HOW BODY MAINTAINS THE CORRECT
SUGAR LEVEL
METALS CAN BE MELTED BY LEVITATION
EARTH IS A DYNAMO
HOW DO THE FIREFLIES EMIT LIGHT?

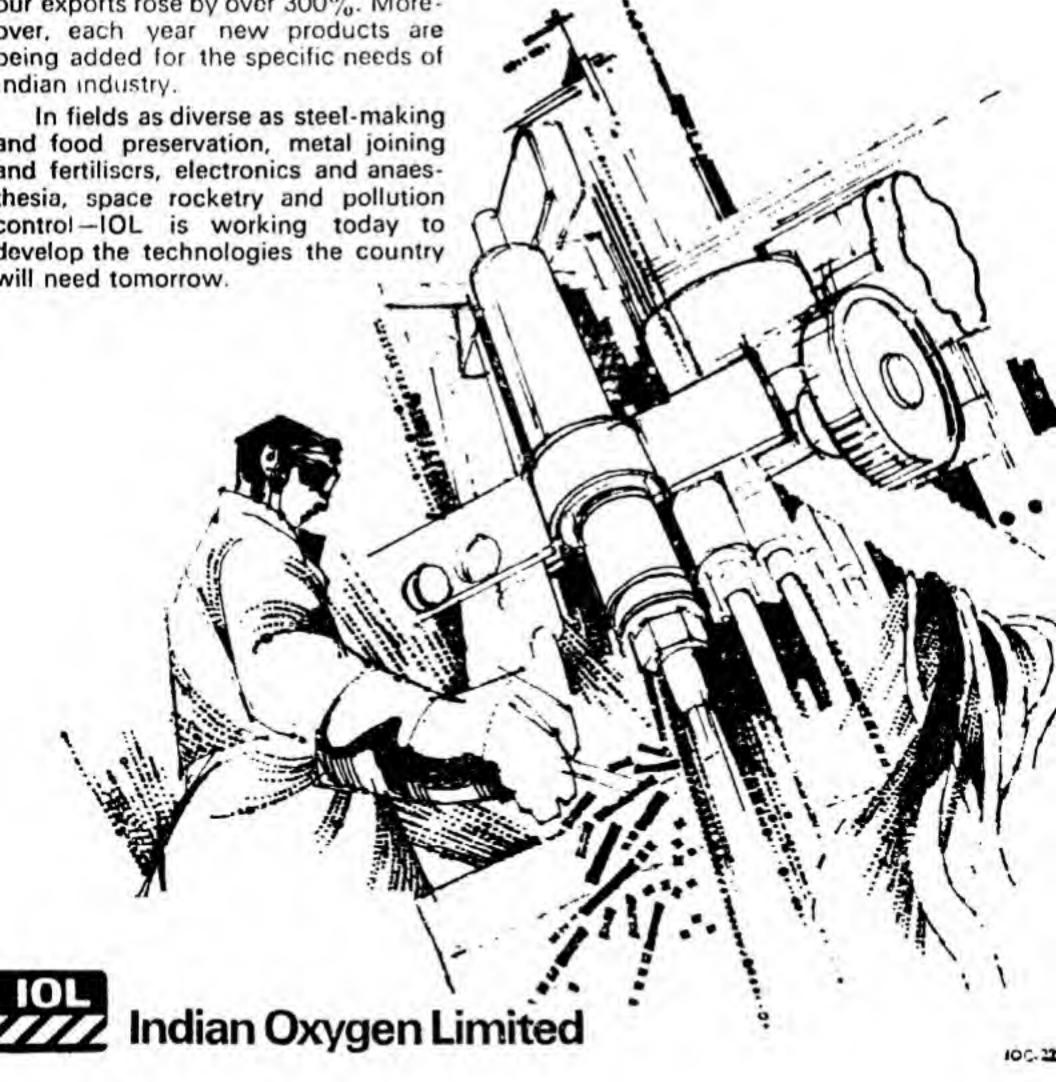
OL technology takes us on to tomorrow.

We are a committed Company. Norking towards economic growth. mport substitution, earning foreign exchange, giving quality products. providing the best possible working environment for our employees.

Over the years our import bill has steadily declined. Whereas in 1973-74 our exports rose by over 300%. Moreover, each year new products are being added for the specific needs of ndian industry.

In fields as diverse as steel-making and food preservation, metal joining and fertilisers, electronics and anaeshesia, space rocketry and pollution control-IOL is working today to develop the technologies the country will need tomorrow.

IOL is commitment





it is necessary today

not only to increase production but to improve distribution and to go ahead with our socialist programme; but even more important to hold our country together.

-Indira Gandhi

NATION-BUILDING

to our contributors

- SCIENCE REPORTER welcomes articles of absorbing interest on science and technology. Contributions
 published in the Journal will be paid for.
- Articles should be sent to the Editor, SCIENCE REPORTER, CSIR, Rafi Marg, New Delhi-110001.
- The form and manner of presentation of the subject should be easily understandable to the undergraduate level.
- The length of the article, written exclusively for the Journal, may be about 2500 words.
- The matter should be typewritten, double space on one side of the paper; the original and a carbon copy are to be sent.
- The article should preferably be illustrated; captions and legends typed separately and attached at the end of the article. Photographs should be on glossy paper.
- While quoting names of scientists, etc., their initials, nationalities and periods of research under reference should invariably be mentioned. All weights and measures should be given in Metric Units.
- A short note about the contributor should also accompany the article. The note should contain age,
 academic accomplishments, important assignments held, fields of research and hobbies.
- Articles or illustrations published in the Journal can be reproduced with permission of the Editor.
- The Editor reserves the right to reject even invited articles without assigning any reason.

SUBSCE	RIPTION
FORM	

To

The Editor
SCIENCE REPORTER
C.S.I.R., New Delhi-110001

Name	
Full Address	
(in capitals)	
PIN	
(Old Subscription No)	Signature
NOTE: Please meeties old Subscription No. in M.O.	comou also.

S.S. Choudhary



368 LETTERS

390 PLANETS AND THEIR POSITIONS-AUGUST 1976

MAIN ARTICLES

History of memory H.K. Singh

The riddle of gravitation A.W. Joshi

405 Effects of nuclear radiations on polymers Neeta Bohidar

412 Insulin and glucagon: The twin hormones B. Pal & J. J. Ghosh

418 Melting by levitation G.S. Reddy & H.S. Ra

SCIENCE SPECTRUM

Past dynamism of earth-Radio astronomy-On the time of vernal equ nox-Anomalous natural reactors at Oklo-Some proteins are sweet Enriching food with amino acids-Kaolinite-an antitranspirant for dry land crops-September-October blooming chrysanthemums-Right eyec left eyed—Mystery of the firefly luminescence—Oxygen too is toxic

436 NEWS AND NOTES

Utkal University felicitates Prof. P. Parija-International Committee for Solvent Extraction Chemistry and Technology

437 MEDICAL NOTES

Antileukemic principle isolated-Women over forty have a greater ris from pills-Estrogen linked to uterine cancer

438 SCIENCE FOR THE YOUNG

Light and its nature—Clippings from astronomy—Where is the fallacy Science Crossword Puzzle

444 SCIENCE IN INDUSTRY

Lead acid battery charger-Improved wick stoves-Small capacity water tank in ferrocement

446 BOOK REVIEWS

Science Year: The World Book Science Annual—Molecular Transformation in Inorganic Chemistry-Atomic Structure and Periodic Classification-Electricity and Electronics

Annual Subscription

cience Reporter is issued monthly.

he Council of Scientific & Industrial

esearch assumes no responsibility

r the statements and opinious

vanced by contributors.

Rs. 10.00 nland :

\$ 5.00

Editor: S.P. Ambasta Asstt. Editors: C.B. Sharma, Zaka Imam altorial Staff: Dilip M. Salwi, Nisha Misra Sales & Advt.: G.N. Jaswal, G.E. Salpek Production: V.S. Chaturvedi

Foreign :



e coutrel

Sir, Electrostatic precipitation has een acknowledged as an important chnique for removing fine particles rom air or other gases. However, he authors in their article Electrotatic dust collector (S.R. January, 976) did not touch upon its potential s a means for removing gaseous ollutants. Electrostatic percipitator as several characteristics which night be exploited for this purpose. mong them are corona discharge as site of intense chemical activity, the orona wind as a means for mixing he gases and a low pressure drop eveloped across the precipitator by he flow. Corona wind is the flow nduced by ions along the diameter f the precipitator. This flow imroves the mixing of the gases, and herefore the contact between the ollutant and the layer of catalyst.

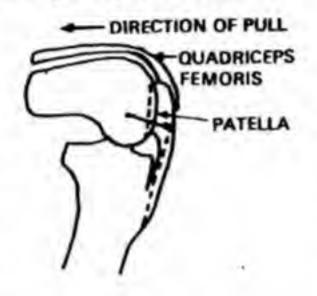
Depending upon the properties of particular pollutant and other onstituents in gas, a variety of hemical reactions are, therefore, ossible. Sometimes oxidizing haracteristics of the precipitator can e enhanced by placing a layer of atalyst or the grounded electrode nd arrangements made to operate ne precipitator at elevated temperaares. With these arrangements, high onversions of hydrocarbons and igh selectivities for CO, are attainble with very little partial oxidation roducts. Such a system, therefore, as characteristics which are essential or the abatement of gaseous polluints in air.

A.D. TADWALKAR Research Scholar Department of Chemical Technology Bombay-400019

Patella

Sir, In S.R. April, 1976, Jyotirmoy Hui has posed two interesting questions regarding the removal of patella. I want to reply to his with two illustrative questions diagrams.

Experimental work has shown that the patella or the knee-cap is a mechanical hindrance during the earlier degrees of extension of the knee (Fig. 1). Indeed the removal or excision of patella will result in increased efficiency of the movement during that part of extension.





But in the later degrees of extension (say 150°-180°), the patella assists in the movement by holding the tendon of the quadriceps femoris muscle away from the axis of movement (Fig. 2), provides additional leverage and thereby increases the extending momentum of the muscle. Hence, the removal of patella will greatly decrease the efficiency of the movement of extension during the later part.

Therefore, overall effect of the

removal of patella has generally bee reported as resulting in some weal ness and disability of the knee join (J.V. Basmajian, Grant's Method of Anatomy, William's & Wilkins Con pany, 1971). A patient will b able to walk even after the excisio of patella, but it is not advisab for persons desirous of running fast.

> VINAY KRISHN Department of Anatom King George's Medical College Luckno

Neem

Sir, The article Neem as a medicina plant by Anand O. Prakash (S.A. Feb., 1976) was quite informative It may be understood clearly that Meetha neem is the common Hind name of Murraya koenigii sprens a member of Rutaceae and thi is not the variety of neem-Azadirachta indica Linn. which is member of Meliaceae. Leaves of Meetha neem are used as cond ments. However, I have heard about the non-bitter variety of Azadira chta indica but I have yet to com across such a plant.

> P.C. KOTWA State Forest Research Institut Jabalpur (M.P.

> > II

Sir, I have read the interestin article Neem as a medicinal plan (S.R. Feb., 1976) and would like to add: A few years ago it was dis covered at I.A.R.I. that the seed of neem can be used as a very effective anti-feeding material against th desert locust. If a 0.1% suspension of the kernel of the seed of the plan is sprayed on any crop, it remain practically safe from locust attack for about 3 weeks. This is a poten weapon to protect the small holding of the farmers when locust swarm threaten to invade crops, until such time the swarms are killed by large ale insecticidal operations from e air or by ground squads.

> T.V. VENKATRAMAN Professor of Entomology (Retd.) Madras

Social drugs

Sir, I have a few questions about ocial drugs in misuse (S.R. Dec., 975).

1. Can any of the drugs mentiond in the article change the composion of blood?

2. What type of abnormalities can

here be in a person who has been an ddict to "M " for three years?

3. Is there any chance for an ddict to lead a normal life after he as stopped taking drugs?

4. Will his progeny be affected any way?

J.B.S.

- 1. None of the drugs referred to the article is known to change the omposition of blood on a permanent asis. However, when any drug is ken, there may be a temporary iochemical change lasting so long s the drug is present in the blood.
- 2. "M...." is a combination of iphenhydramine and methaqualone nd is used as an anti-anxiety agent. ersons taking this drug are known be acutely tense and tend to neglect heir responsibilities. They have also een noticed to indulge in irrelevant ilks. Overdosing with M.... may ad to cardiovascular complications ke shock, myocardial infarction and ardiac arrhythmia. The blood cloting mechanism may also be impaired n some patients if it is used in excesive doses.
- 3. There is every chance of a erson living a normal life after he as given up addiction to M....
- 4. There is no evidence of progeny eing affected in any way.

B.M. MITHAL Deptt. of Pharmacology Birla Instt. of Tech. & Sciences, Pilani Rajasthan

Cosmetics and pimple cream

Sir, P.S. Dubey in What cosmetics are made of? (S.R. Nov., 1975) did not say whether one should use cosmetics or not. Are cosmetics harmful to skin? Also, he has not said anything about pimple creams. Do pimples really disappear with the use of such creams?

> V.G. SHIRKHELKAR Chandrapur

On the desirability of using cosmetics, opinions differ. However, it would be, perhaps, in the larger interest to conclude that cosmetics should not be used without caution. It has occasionally been seen that use of hair-dyes has caused severe eczema of the scalp. Again, powders not containing a suitable antiseptic give skin troubles. Safety of health must overweigh false appearance.

Pimple creams are cold creams containing borax or other compounds of boron. Such creams should be recognised medicines rather than cosmetics. In fact, pimples in medical terminology are called acne which is a chronic inflammatory disease of the skin involving sweat glands. Acne is characterised by white heads (closed comedones), black heads (open comedones), papules, pustules, vesicles, nodules and scars. Most of these lesions are sterile and staphylococci are a minor element in the disease. Indigestion, constipation, sexual disorders and over-indulgence in sweets are not the only causes for its appearance, development and continuation. Acne generally appears in youth and disappears afterwards.

There is perhaps no sure treatment of acne (pimples) and therefore pimple creams sold in the market can hardly be of any help. Prolonged exposure to sunlight may sometimes prove useful.

> P.S. DUBEY Bareilly College Bareilly (U.P.)

Hyperchromic

Sir, I would like to draw th attention of my fellow readers S.R. to the usage of the terr hyperchromic while describing stained peripheral blood smes in a person suffering from certain anaemia.

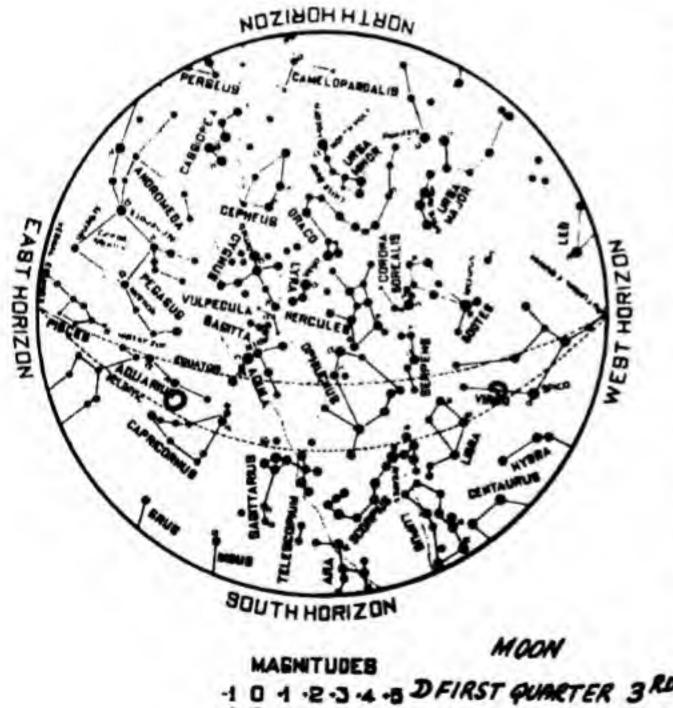
According to the content of haemo globin in erythrocytes of blood three states of the cell can be de cribed. The cell may be norme chromic when the haemoglobin con tent is normal, hypochromic when is below normal and lastly hyperchro mic when it is in excess. The forme two terms are used by all author Confusion arises when the terr hyperchromic is used to describe th erythrocytes of certain anaemia. M M. Wintrobe in his book Clinica Haematology (6th Edn., London 1967) even condemns the usage (the term hyperchromic. He poin out that the haemoglobin content of the erythrocytes increases parallel with the volume of each cell and wi not be found in excess. The follow ing lines can be quoted from Harr son's Principles of Internal Medicin (7th Edn.): "Red corpuscles in pern cious anaemia and in other macrocyt anaemias are not hyperchromic by being thicker as well as larger i diameter than normal corpuscle they appear to be supersaturated wit haemoglobin, as one looks at the through a microscope.

What is more confusing is th contradictory statements of clinical findings in pernicious ansemia Some say that pernicious anaemia normochromic whereas others (in cluding some Indian authors) say is hyperchromic. Certain others eve say it is hypochromic. The usage of this still ambiguous term is open t question and discussion, if at all th term is allowed to be used.

> G.N. LAKSHMINARAYA Coimbatore Medical College Coimbator (Continued on page 404

Planets and their positions

AUGUST 1976



1 0 1 .2 .3 .4 .5 D FIRST QUARTER 3 RD O FULL MOON

The moon

Full moon occurs on 10th at 5-14 m. and new moon on 25th at -31 p.m. I.S.T. The moon passes bout a degree south of Jupiter on 8th, about six degrees south of aturn in the early hours of 24th, five egrees south of Venus and about alf a degree south of Mercury and three and a half degrees south of Mars in the evening of 27th. The lunar crescent becomes first visible after the new moon day in the evening of 27th.

The moon is at perigee or nearest to the earth on 1st and again on 28th and at apogee or farthest from it on 16th.

The planets

Mercury (Budha), an evening star sets about an hour after sunset during the month. It passes very close to the star Regulus (Magha) on 3rd being less than a degree north of it and comes very near to Mars by the end of the month. It is at the greatest eastern elongation of about 27 degrees from the sun on 26th. It moves from Lec (Simha) to Virgo (Kanya). Its visua magnitude varies from -0.4 to +0.6

Venus (Sukra), an evening star, set about an hour after sunset during the month. It passes about a degree north of the star Regulus (Magha on 7th. It moves from Cance (Karkata) to Virgo (Kanya) through Leo (Simha). Its visual magnitude i about - 3.3.

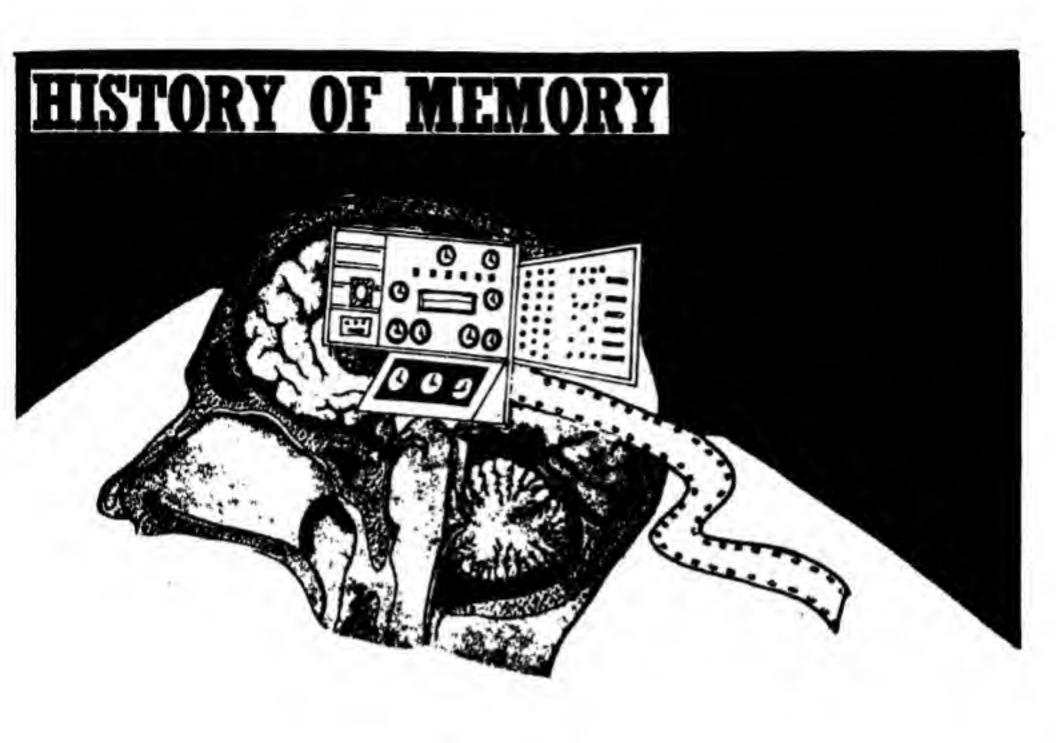
Mars (Mangala), visible in the evening sky, sets about two hour after sunset during the first half o the month and about one hour afte it during the second half. It move from Leo (Simha) to Virgo (Kanya) Its visual magnitude is about +1.9.

Jupiter (Brihaspati), visible in th morning sky, rises at about loca midnight during the first half of th month and about an hour before i during the second half, being i quadrature with the sun on 23rd It is in Taurus (Vrisha). Its visua magnitude is about -2.0.

Saturn (Sani) is too near the sun t be visible during the first half of th month. In the second half it reappear in the morning sky and rises abou one and a half hours before sunrise It is in Cancer (Karkata). Its visua magnitude is about +0.5.

During the second half of th month the three planets Mars, Mer cury and Venus (above to below) as seen very close to each other in th western sky after sunset. In th evening of 27th, the moon will als pass very near to them keeping Me cury and Mars in its nothern side an Venus in the north-western side. (Source: The Nautical Almanac Un of the Meteorological Office, Alipor

Calcutta-700027).



I. K. SINGH

How does a man remember things he has seen or heard in the past? How does he, at particular times, recall a past experience? These are the problems that arise in the study of memory

THE learned sages of ancient India did not possess a clear oncept about the function of brain and believed, like their contempories in China, Egypt and Greece, nat heart was the source of intelligence. The importance of spinal ord was, however, realized. The xistence of the nervous system was snown but not properly understood. With an immense interest in metahysical problems and a rich tradition of lively debate and discussion,

a distinctive system of logic and epistemology gradually developed in India. They started debating on terms like 'thinking' and this process was regarded as the defining attribute of Man. Likewise, the Greek philosopher Artistotle assigned rationality (capacity to think) as the distinctive quality of Man. Another illustrious Greek philosopher Descrates attempted to distinguish mind from matter by characterising the former as 'that which thinks'. Both,

the sages of ancient India and philosophers of Greece, were seized of on of the most distinctive human capacities, viz., 'thinking' in definition: Even today no branch of psycholog would be complete without a seriou attempt to describe what a man downen he is 'thinking', or how a mamemorises his thinking and how a particular times he is able to recap a past experience. These problem which till yesterday were lying at the periphery are today dealt with

altogether a distinctive branch of natural science called neuroscience.

Any mature living creature in a situation in which it is thinking, brings back the entire repertoire of his past experiences, habits and dispositions. Therefore, 'learning' and 'memory' important prerequisites for 'thinking' to take place. It is not easy to define learning and much less to know the process underlying learning. According to the definition given by Thomson (Durham University, U.K., 1959), "Learning is any change in the general activity of an organism the effects of which persist and recur over a period of time and which are strengthened by repetition or practice." Even this general definition was considered to be speculative at that time, as sufficient evidences were not available in the scientific literature to support Thomson's contention. Matthies Academy, (Medical Magdeburg, GDR, 1971) gave a more concise definition: "Learning is the elaboration of strategies against a definite class of disturbnces, using a multistable system of stable sub-systems."



le: "I remember every word you say."
The: "After marriage, I should be nore interested in how soon you can orget things than how long you can emember them."

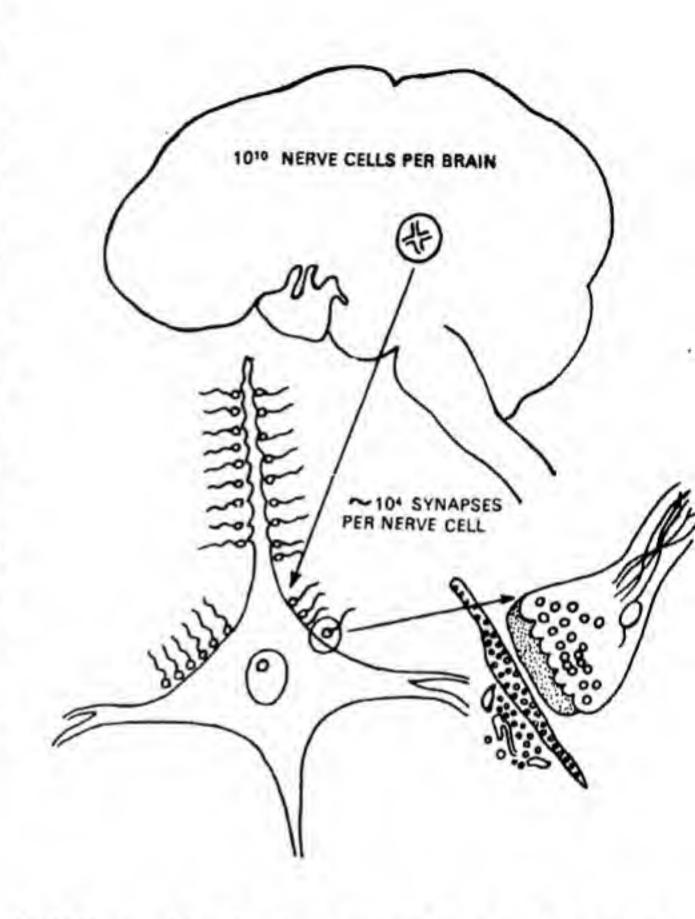


Fig. 1. The transmission of excitatory impulse from one nerve cell to another tak place at the synapse. There are vesicles at the nerve endings, in which transmitt is stored. On being stimulated, the transmitter is released causing stimulation of the next nerve cell

This definition was not considered speculative as Matthies, together with many other scientists from different parts of the world, had enough material evidence in support of this definition. The difference in these two definitions also signifies the strides made by neuroscience between 1958 and 1971.

How is memory formed?

During this period, the major effort of many neuroscientists was to clarify the basic mechanisms involved in learning and memory formation Recent progress in molecular bid logy, particularly development in the knowledge about the function of nervous system, the near perfection of some highly sensitive and specific physical, biochemical and morphological techniques and progress in theoretical knowledge in cybernetic has made possible successful research in neurosciences. Accordingly many theories, some of them ver speculative, have been proposed to explain how memory is formed.

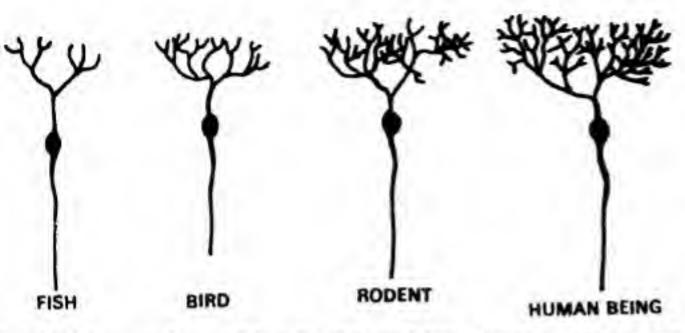


Fig. 2. Interseuronal connectivities in four different types of species. The efficiency of brain performance depends upon the number of these connectivities

The new concepts involved in the nderstanding of "memory" are rimarily based on animal experients. This is mainly because ethics orbid the performance of experients on human beings, apart from e fact that the memory formation human beings is relatively diffiult to investigate on account of their aving a more complex nervous stem. However, a comparatively mpler memory formation and learng events in animals can be used as a odel. Because the functions of erve cells of human and animal rains are essentially the same, it is so to be expected that the mechaisms of memory formation will ave a general validity. Further, the umber of cells and their connectiities with each other in the human rain is much larger—the approxiate number of each nerve cell aving connectivities with other cells of the order of 2×10^5 (Fig. 1). esides, we know from the history f development of brain that in the igher animals the number of inrneuronal connectivities is always n an increase (Fig. 2). Nobel aureate Professor J. Eccles (forerly of Australia, now in the USA) as demonstrated this very clearly n a particular type of cell, i.e., etencephalon (hindbrain) in verterates. It is generally recognised that creased neuronal connectivities are

f special significance for develop-

ent of higher neuronal activity.

The formation of new neuronal connectivities is therefore a manifestation of events leading to memory and learning in individual cases.

Many researchers have investigated the correlation between the nerve cells and their connectivities in the rat brain by manipulating experi-

mental environments. For instance a single rat was grown in a narro empty cage or rats in groups we brought up in spacious cages in th presence of different objects such a toys, etc. The idea behind suc manipulations was that social cotacts and an enriched environmen will enhance learning and the acquis tion of new information leading to a improved memory. These exper ments have shown that anima brought up in an enriched environ ment did have more spots (in th brain) where connectivities betwee nerve cells take place compared to the animals bred in a poorer milies Similar differences were also observe between animals bred in comple darkness and in normal light. Be these differences were observed on in those parts of the brain where the neuronal circuits from the eyes en

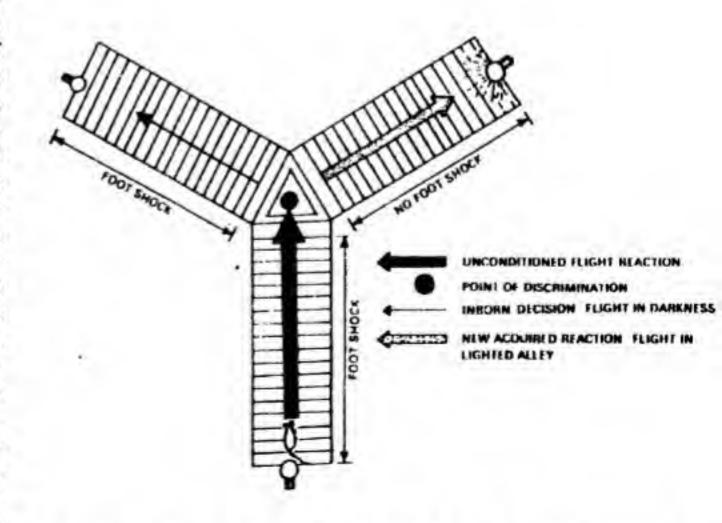


Fig. 3. The rate are given foot-shock through the grid floor (represented by her sental line). This grid causes the release of an unconditioned fright reaction. At the point of discrimination, the unions has to choose to run either in dark or in a lighted alley. The inhere reaction is to run towards dark—in a foot-shock punishment in a dark alley makes the minual to leave run in the lighted alley where no foot-shock is given. Because of a radic symmetric arrangement in the Y-mans, the terminal (lighted) alley can be used the start-loop for the next trial

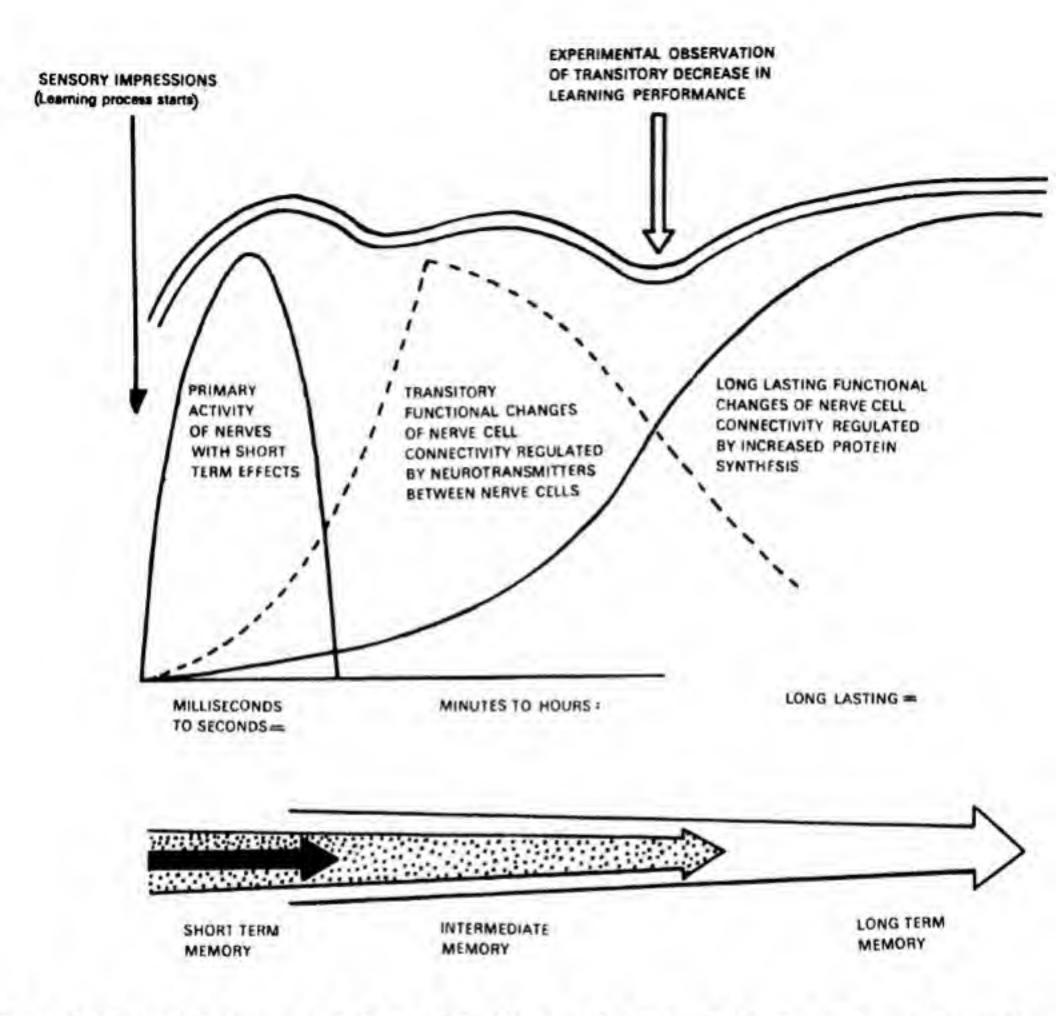


Fig. 4. The process at the synapses and in the nerve cells which are involved in memory formation are presented schematically

e., pyramidal cells of visual cortex. is, therefore, inferred that during arning the excitated nerve cells ig on the durability of these connecvities, the reproducible excitation attern of the participating cells kes place and this forms one of the aportant basis of memory. Some oubts, however, have been raised n this phenomenon of formation of ew synapses (connectivities between ells), as it was difficult to conceive at the new synapses could develop ithin seconds or even minutes. Many

scientists found it difficult to conceive that this phenomenon manifests the basis of formation of memory evelop new connectivities. Depend- traces or engrams. According to another theory, known as aggregate field-theory, memory depends on the formation and maintenance of circular, electrical waves in the available range of neuronal circuits. But this theory is also not without contradiction, as it is possible to bring the electrical activity of the brain transitorily to a standstill through experimental manipulations without erasing memory traces.

Some clinical observations, demon strating the existence of differen types of memories, resolved to a great extent some of these contradiction For instance, if a man gets a con cussion of the brain, he canno remember the events just prior to th accident, whereas the memory of pa events is not disturbed (technical known as the loss of recent memory The fresh and recently acquire memory, known as short-teri memory, appears to be very sens tive to brain concussion. Apparent there exists another form of memory



"For writing a book on history of memory, you should first have a good memory for history."

known as long-term memory, which is not sensitive to heavy concussion.

On account of these clinical observations, various experimental investigations were undertaken to establish the biological mechanisms and fundamentals of both forms of memories. A type of brain concussion was induced in animal experiments by administering electroconvulsive shock (15 mA, 25 m sec.). When this electroshock was given at different times after learning, the memory erasing effect gradually decreased as the time interval of giving the shock increased. This method could show to some extent the commencement of the long-term memory and the period of its transitory storage during the phase of short-term memory. Further, it could also be demonstrated that during short-term memory an improvement of memory could be obtained either through a stimulant of central nervous system like amphetamine or by electrical stimulation of those brain structures such as hippocampus, which are considered responsible for the activation of brain function. These results also support the general experience that high attentiveness and awakenness have a favourable effect on learning performance and fatigue and distractions have unfavourable effects.

The long-term memory formation, which is relatively gradual, ranging from minutes to hours apparently supported the view that the new connectivities between nerve cells form the basis of long lasting memory. As the increase of such new connectivities, like other growth process, is closely related to protein synthesis within the nerve cells, an impairment of long-term memory formation was to be expected through inhibition of protein synthesis. From the results obtained from molecular biology, one also knew that protein synthesis is controlled by nucleic acids, so that an inhibition of the synthesis of the appropriate nucleic acid could also cause disturbance in memory formation. In fact, it could be seen

in fish, rats and mice that after inhibition of protein synthesis in brain, the animal could still learn and store the task thus learnt, but after a few hours the memory deteriorated and gradually diminished. Neither learning ability nor short-term memory could, therefore, be impaired through an inhibition of protein synthesis, but an impairment of longterm memory was observed. These findings proved the significant role of protein synthesis in the formation of memory molecules, but process is obviously not relevant in the retention of short-term memory.

Protein synthesis and memory

The investigations with inhibitors of ribonucleic acid (RNA) synthesis

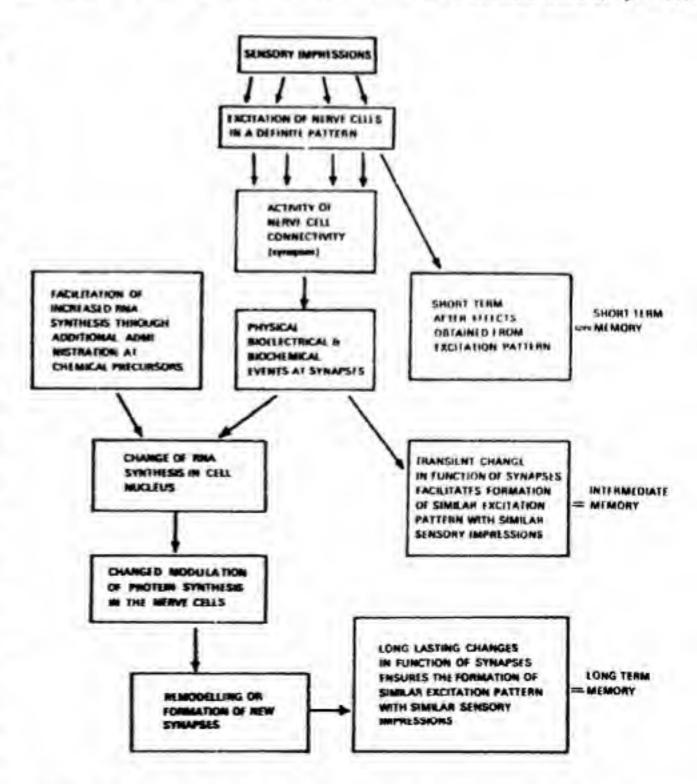


Fig. 5. The different phases of memory formation. Because of insufficient overlapping of individual phases, transitory decrease (deliciency) in learning performance can be observed.

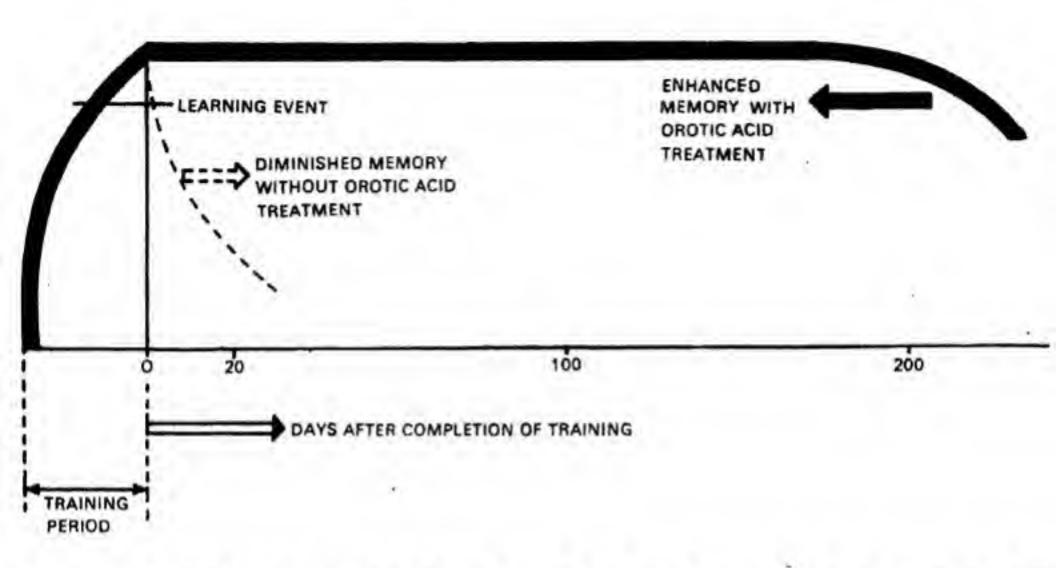


Fig. 6. Prolonged memory (delayed extinction) of a learned reaction in rats through treatment with RNA precursor—orotic acid

vere, however, less well defined nainly because of their disturbing ide-effects. Actinomycin-D, a otent inhibitor of RNA synthesis, howed extreme toxic effects when iven locally in as low a dose as 1.5 µg. per hippocampus. It was loo difficult to measure the behatioral effects of these inhibitors at estied time intervals. Therefore



The trouble with the Book Award committee is that it cannot take a ecision whether my book is memorble history or historical memories."

scientists investigated the direct participation of protein and RNA synthesis in the memory formation. For this, they used the isotope techniques and determined the incorporation of labelled precursors into proteins and nucleic acids of nerve cells under conditions of a learning experiment. Thin brain slices were prepared from treated animals and coated with photo-emulsions. An intense blackness of radiation sensitive layer was found at those spots in the brain, where a strong incorporation of radioactive precursors took place. These studies helped to establish that learning leads to an increase of protein and RNA synthesis and also the localisation and nature of nerve cells of brain which are involved in the learning process. These autoradiographic investigations clearly established that the formation of long-term memory is accompanied by increased nucleic acids and protein synthesis.

The results briefly summarised here are not as straightforward as indicated and are not without contradictions. The main reason is that investigations

have been done in different laboratories using different experimental procedures and animals of varying species, thereby making a comparison of results extremely difficult It is for this reason that research team of Matthies deided to investigate on a specific model of learning experiment with rats, to study the dynamics of the learning event and memory formation at different time with a view to throw light on the cellular and molecular mechanisms involved.

The experimental model the researchers chose was the so-called shock motivated brightness discrimination (Fig. 3). This model was chosen because the particular type of learning is both observable and measurable and involves participation of cerebra cortex. It also offers the possibility of subjugating the animals to all procedures of the experiments without their actually learning anything, so that such animals can act as yoked Moreover, the (active) controls. entire apparatus is automatically manipulated through a control panel eliminating the subjective influence of the experimenter which is an extreely important factor in behavioral vestigations.

Through a combination of bioemical, auto-radiographical and ectron-microscopical investigations one on this model of learning, it ould be demonstrated that there was n increase of ribonucleic acid and rotein synthesis during the formaon of long-term memory. The ynamics of long-term memory ormation could also be established, s the above mentioned increases in NA and protein synthesis express hemselves in metabolic changes at ifferent times in different phases and lso in the participation of individual rain regions during the formation f memory traces.

In this learning model the fornation of stable and permanent nemory traces is completed within hree to four hours. This fact could e established by seeing the decrease n sensibility of memory to electroconvulsive shocks (0.1 mV, 3 sec. in his case). The question still uninswered was how the memory was etained in the formative stage of three to four hours. The theory of fuctuating brain waves (also known is field-potential) mentioned earlier might as well be responsible for this storage. However, this could not be experimentally established. further investigations, it was found hat from termination of the training ill the formation of permanent nemory traces, strong changes in the chemical transmitter systems between the nerve cells take place. These might represent the basis of a type of intermediate memory between short and long term memory.

Matthies model

On the basis of above findings and those obtained by other investigators, Matthies and his associates proposed a model for the molecular and cellular processes and their temporal expiration in the memory formation (Figs. 4, 5). This model also enabled manipulations of memory formation

based on the assumption that the first stage of biochemical changes in the long-term memory formation involves an increase in the synthesis of ribonucleic acid. It was also assumed that long-term memory begins when the RNA synthesis has reached an optimal level. To give support to this assumption, the experimental animals were treated with sufficient amounts of a chemical precursor of RNA, vir., orotic acid before the commencement of learning experiments. A substantial prolongation of memory in such animals was observed. In the untreated controls, a spontaneous dwindling of memory (atrophy)-a stage of complete forgetfulness-after 13 to 15 days was observed. The treated experimental animals showed predominantly good memory performance even after 200 days (Fig. 6). This treatment was also found to lead to a significantly increased synthesis of protein than could be observed in the untreated rats. For the first time the retention of memory could be modified to such an extent. They further demonstrated that the mental performance might be influenced by administration of some specific substances.

Although many questions still remain unanswered, the possibility of practical application of some of these results, say, in disturbed brain function cannot be ruled out. Supplementing the diet with proteinrich food specially during 0-5 years of a child invariably has shown a good effect on the mental performance of the individual. In some clinical observations it has been found that orotic acid has an improving effect on mentally retarded children. It can, therefore, also be contemplated that substances like D-Fucose which help the binding of endogenous protein at the receptor site will also help the mentally retarded children to gain normalcy. But, these findings do not suggest the possibility that in the very near future

we might find ourselves in an era of 'pills for memory'. It is never going to be possible to store an information permanently in one's memory by swallowing a specific memory pill. The neuroscientists, however, will definitely be able to tell how to enhance the mental retention capacity. For generations to come one will have to rely on his mental creativity and inclination and not the pill to acquire new knowledge. Therefore, Goethe's exhilaration on the mental excellence of man will still have a real significant validity: Was Du ererbst von Deinen Vaetern. erwirb es, um es zu besitzen. (What you inherit from your forefathers, earn it, in order to possess it . .).

Work done in India

Unfortunately, not much work has been done in India to elucidate the processes underlying the mechanisms of memory and learning. Our scientists have yet to develop a general interest in this field, whatever little work has been done is the sporadic contribution of individual authors.

P.C. Dandiya and associates (Jaipur) have shown that ampheta mine induced stereotypy increases the locomotor activity for two hours. The initial 30 minute increase is due to the biogenic amines norepinephrinand dopamine while the rearing stereotyped behaviour observed during 30-120 minutes is mainly due to dopamine.

R. Sukumar (Bangalore) trained male grasshoppers Poecilocera pictorin a conditioned avoidance task and found that they learnt at a faster rate and retained the learned behaviour longer than females. An increase if the concentration of RNA in the metathoracic ganglia was also see in the insects after the training process of changing leg position to avois shock was completed. It was further found by Sukumar that prostigming (also known as neostigmine), which increases the content of the neuron transmitter acetylcholine due to it

Defective memory

O NE'S capacity to recollect events, experiences or performances which belong to the past is called memory. It is based upon earlier perceptual activity and normally requires some current perceptual activity also, to set it into operation. If a person remembers some event, his present behaviour is influenced by its past experience.

Defective memory may be caused mainly due to three factors: (1) the mind may be preoccupied, or the attention may be diverted towards other subjects during perception. It is common in case of neurosis; (2) influence of toxins which poison and damage the brain. Toxins may be of organic and inorganic nature; and (3) hysteria.

In neurotic persons the ability to forget is high, even abnormal. Moreover, whatever does not suit them to

nticholinesterase property, hastens he learning process and certain dyes ke acridine orange and congo red etard it appreciably.

M.M. Dhar and associates Lucknow) have demonstrated by acorporating a synthetic peptide hat the foreign protein is recognised y a living system only through its nessenger RNA.

remember, they forget. And when they are unable to make contact with their environment they become panic striken. In fact their power of retention and recall is not faulty, but the fault lies in their inability to take impression. The vast majority of each of poor memory in young persons belong to this type.

Defective memory of organic disorder such as damage to the brain, may be due to toxins produced by alcohals, drugs, etc. Here the person has a clear recollection of the distant past, but a faint memory of recent events.

Patchy defects of memory may result from diseases and it is usually transient, but brain cells if damaged once, cannot be replaced. Sometimes organic memory defects can be prevented by the intake of vitamin B. N.B.

The Regional Research Institute at Calcutta has developed and synthesised a drug which is a phytoproduct of Marsella quadrifolia. This drug was given extensive clinical trials at various hospitals and was found to be very efficacious in rectifying mental disorder and reducing blood pressure. According to G.D. Mukherjee, Marselia quadrifolia

when given in equal proportio with Acoral calamus acts as potent brain tonic.

Yet another 'pep for idiots' claimed in Ayurvedic literature, i.e Bacopa monniera, commonly know in vernacular language as Brahm At present experiments are bein done at the Central Drug Research Institute in Lucknow to screen an ascertain the memory enhancing property of this drug.

Further reading

- 1. Dhar, M.M., Agarwal, A.K. Mathur, K.B., Ray C.: A Mech anism for the distinction of foreign proteins by living system based on peptide directed RN. synthesis. Ind. J. Biochem Biophys., 10 (3): 227-228 (1973
- 2. Eccles, J.C.: The Physiology Springer Verla Synapses, Berlin (1964).
- 3. Eccles, J.C.: Conscious exper ence and memory in Brain an Conscious Experience, Ed. b J.C. Eccles, Springer Verlag Berlin (1966), pp. 314-344.
- 4. Erickson, C.K. and Patel J.S. Facilitation of avoidance learn ing by post-trial hippocampe electrical stimulation, J. Camp Physiol. Psychol., 68, 400-40 (1969).

MEDICAL NOTES (Continued from page 437)

ging by women—particularly those trols having other gynecologic neo- the risk increased with duration o s the incidence of cancer of uterus increasing, D.C. Smith and his ssociates at Seattle's University f Washington investigated whether here was an association between the acreasing incidence of uterine cancer nd the expanding uses of estrogen by enopausal and post-menopausal omen. By retrospectively comparng patients having uterine cancer rith equal number of matched con-

the upper socio-economic levels. plasms, these investigators found that the risk of uterine cancer was at least 4.5 times greater among women exposed to estrogen therapy (New Engl. J. Med., 1164, 293, 1975). In another study, H.K. Ziel and W.D. Finkle of Los Angeles, Kaiser Parmanente Medical Center found about 8 times greater risk among women exposed to therapy using conjugated estrogens (principally sodium estrone sulphate) and that

exposure (New Engl. J. Med., 293 1167, 1975). It should be clear tha these two studies did not prove tha estrogen hormones caused cancer of the uterus, but they suggested a rela between the increases tionship frequency of uterine cancer and the increasing use of estrogen hormones

> R.K. DATT. Beth Israel Medical Cente New York, N.Y. 10003, U.S.A

There are no two men whose ictures of the world would coincide in every respect. The istory of the theories of ravitation through the ages confirms the truth of this observation

A.W. JOSHI S.S. CHOUDHARY

To describe the physical world around us, to explain its changing elements and the different kinds motion in it, requires a study nat has occupied man from prehistoctimes.

The knowledge and understanding of gravitation acquired in the past three centuries forms a tery interesting story.

ise of Newton

The publication of Sir Isaac Newon's Principia in 1687 was one of
the most notable events in the history
of physical sciences. In it, one can
and the culmination of thousands of
the ears of work to explain the physics
of moving bodies. He described the
three famous laws of motion and the
niversal law of gravitation. The
otter states that every body in this
niverse attracts every other body
with a force proportional to the
roduct of the masses of the two
odies and inversely proportional to
the square of the distance between

THE RIDDLE OF GRAVITATION



them. The constant of proportionality is denoted by G and is called the universal constant of gravitation. On the basis of these laws, Newton convincingly explained such varied phenomena as the free fall of an object, projectile motion, planetary motion, ocean tides, etc. That is why Pope Alexander once said:

"Nature and Nature's laws lay hid in night/God said 'Let Newton be!' and all was right."

In the eighteenth and nineteenth centuries, Newton's laws were thoroughly studied by many physicists and mathematicians, notably the Frenchmen Laplace, Lagrange and D'Alembert, the Bernoulli family is Switzerland and Leonhard Euler is Germany. The applications of the laws were extended by them. But as the nineteenth century came to close, the outlook was not rost Newtonian physics faced som failures in the wake of accurate observations.

Orbit of Mercury

In the middle of the nineteens century, V.J.J. Leverrier (1811-1877

or. Joshi teaches physics at the Institute of Advance Studies, Meerut University; Shri Choudhary is research scholar at the same Institute

a French astronomer, analyzed the motion of the orbit of Mercury and found some discrepancy in the results predicted by Newton's laws. According to Leverrier's calculations, the major axis of Mercury's orbit should rotate through 527 seconds of are per century as shown in Fig. 1. But according to observations, it rotates through 565 seconds of arc per century. The difference was 38 seconds of arc per century and was much larger than the experimental error. So here lay a substantial disagreement between theory and observation. In fact, more accurate observations that have been made since 1845 show that there is a difference of 43 seconds of arc per century. Many attempts were made by scientists to explain the discrepancy but without much success. An American astronomer, Asaph Hall (1829-1907), even suggested that the Newton's law of gravitation may not be a perfectly inverse square law—the force may be inversely proportional to the n-th power of the distance where n-2±0.01. However, again, recent accurate observations show that n cannot differ from 2 by more than 0.00000001. This small deviation from the inverse square law cannot explain the discrepancy in the



Until I was married, I too believed in Vewton's discovery that two bodies attract each other."

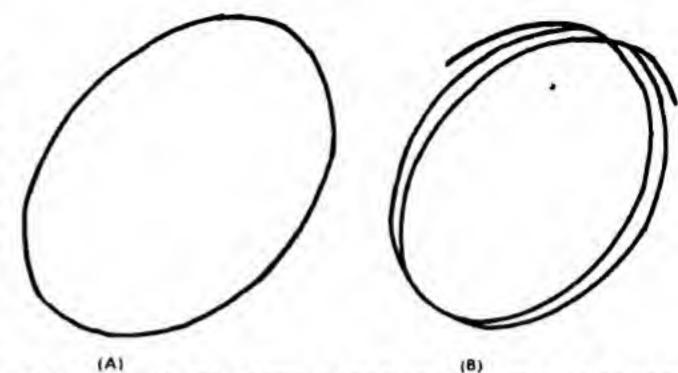


Fig. 1. The orbit of a planet around the sun is not a closed ellipse as in (a) but its perihelion advances with time as in (b)

displacement of the perihelion of Mercury.

Microscopic particles

In the beginning of the present century, it was found that Newton's mechanics completely failed to explain the physics of microscopic particles. The first blow to classical mechanics came when a German physicist, Max Planck, threw away the established rules and made in 1900 the bold suggestion of quantum of action. According to him, the energy transfer from one system to another is not continuous, but takes place by means of discrete quanta, that is, small units. This was the basic foundation of quantum mechanics.

Michelson-Morley experiment

Classical mechanics assumed the existence of an all-pervading medium, called ether, relative to which the motion of every object could be specified. However, sustained efforts to "see" ether failed, giving another blow to Newtonian physics.

The earth, while it revolves around the sun, must move through the ether, which is supposed to be an absolutely stationary medium. The motion of the earth relative to the ether must then be detectable. One of the easiest methods to observe this motion would be to measure the velocity of light with respect to the motion of the earth.

Two American physicists, A.

Michelson (1852-1931) and E. V Morley (1838-1923), took up th problem in 1887. The aim was measure the velocity of the ear relative to the stationary ether b measuring the difference between the velocities of light; one, in the dire tion parallel to the earth's motion ar the second perpendicular to it. For this purpose, they used a very delica instrument called Michelson inte ferometer (Fig. 2). In it, a ray light from a source S strikes a bear splitter BS, which is a half-silvere plate. One beam travels to mirro M, and returns to the telescope while the other travels to M, an returns to the telescope. The tw beams give rise to interference fringe in the telescope. If we assume the the earth is moving in the direction SM, the velocity of light in th direction SM, would be differen from that along M_1T . If the appara tus is now rotated through a righ velocities would b angle. the reversed, producing a shift in th fringe pattern.

After countless observations, with different orientations of the apparatual at different points of the earth and at different times of the year (that is at different points on the earth orbit around the sun), they failed to detect any shift in the fringes. The negative result later turned out to be an important result that gave physics an altogether new direction.

So, by the end of the nineteent

entury, Newtonian physics faced any problems. Many physicists ade several attempts to put them if making minor changes and modications. Some of the noted contributors among them were H.A. orentz (1853-1928), a Dutch physicist, Nobel prize winner G.H. itzgerald (1851-1901), an Irish hysicist; and J.H. Poincare (1854-912), a French mathematician. However, they also did not get nuch success. A drastic change in the basic concepts was required.

lise of Einstein

In 1905, Albert Einstein, then a lerk in a patent office in Germany, leveloped a theory to explain some of the discrepancies in classical physics. He based his theory, now known as the Special Theory of Relativity, on wo postulates. First, the velocity of light in vacuum is the maximum relocity of any material object. In other words, no physical object can nove with a velocity greater than that of light. Second, the laws of nature (physics) must remain the same for observers in uniform relative motion with respect to each other.

The new idea that emerged as a result was that there is no absolute space, time or motion. Every object in this universe is moving somewhere or the other. It is, therefore, not possible to find a fixed reference frame in the universe from where we can measure the position of other objects. We can at best specify the position of one body relative to another. This is known as the relativity of space. Similarly, the notion of time, or more specifically, the duration between two events, is relative. Suppose we observe an explosion in the sun and another explosion in some other star, and measure the duration between the two. And another observer moving in a fast spaceship relative to us also measures it. There will be a difference in value of the duration between the same two

events. Finally, velocity is also relative. It is meaningless to say that an object is moving with such and such velocity. It is necessary to add the phrase, "with respect to such and such object." A stone on the earth seems to be stationary to us. But the stone, along with us, is rotating with a speed of about 1600 m/hour at the equator (relative to the centre of the earth), the earth is itself moving with a velocity of about 30 km/sec in its orbit around the sun (relative to the sun), the entire solar system is moving in the Milky Way galaxy with respect to the distant stars, and nobody knows where the distant stars are movingyet the stone has zero velocity relative to us!

The Einstein's theory of relativity

gave rise to some important and startling results. They are:

Increase of mass with speed. The mass of an object is not constant but increases with its speed. As the speed of the object approaches the speed of light, its mass increases beyond limit and approaches infinity.

Decrease of length with velocity. The length of an object decreases as its velocity in a direction along the length increases. As the speed approaches the speed of light, the length diminishes beyond limit and approaches zero.

Dilation of time. The passage of time slows down as the velocity of an object increases.

Mass is a form of energy and energy has mass. They can be converted

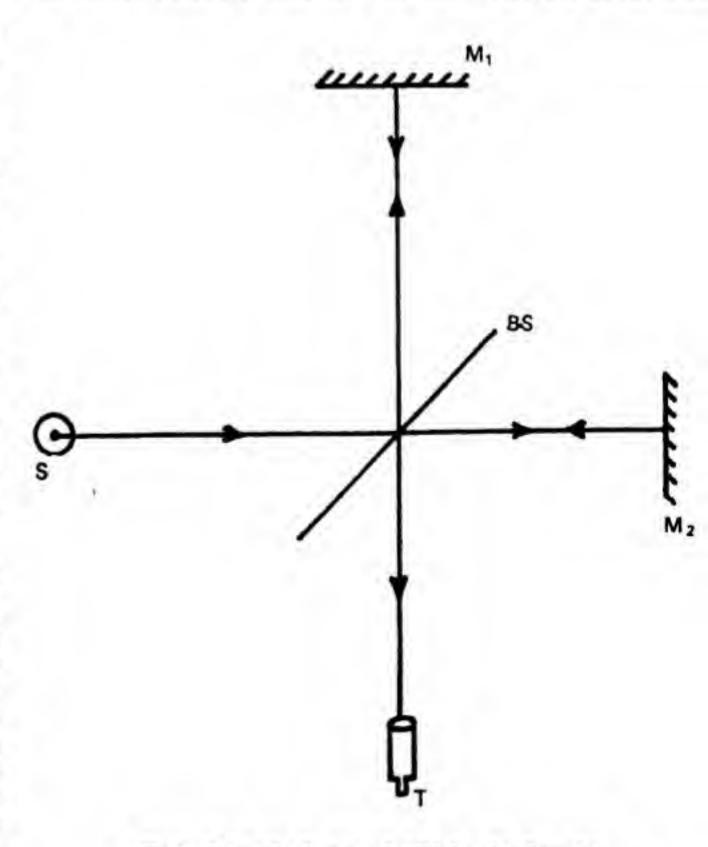


Fig. 2. Schematic diagram of Michelson interferometer

Is inverse square law not valid?

TWO bodies in this universe attract L each other with a force proporional to the product of their masses and inversely proportional to the quare of the distance apart. The gravitational constant, G, rises as a result of this interaction between the two bodies and its much ested numerical value are also well known to us. Today, it has become a basic tenet of physics. So, to rub it off everybody's mind, as a new investigation claims, will be a Herculean task. Reporting in Nature (260, April 1.76), D.R. Long Washington State of Eastern College, Washington, claims that the so-called inverse square law of gravitation is not valid for short aboratory distances.

The law of gravitation, since its postulation by Isaac Newton, has helped in formulating many theories that later proved experimentally correct. The greatest of all is the Kepler's laws of planeary motions which are entirely dependent upon it. The study of satellites and planets has confirmed that the law holds true at astronomical distances, say for 1000 km and above

The doubt about the validity of the inverse square law first appeared when Newcomb explained the anomalies present in the motion of

Mercury by a small modification in the framed law. However, his claims have not been totally baseless, for an interpretation of Einstein's General theory of relativity does indicate such a deviation at large distances, but not for short distances. The inverse square law, the theory claims, is true to the letter. Long's claim will take time before they are clearly understood by scientists. Whether his claims will be proved or disproved experimentally is another matter.

Long's laboratory researches, done between the distances of 4.5 cm and 30 cm, tell that the value of G varies with the distance between two bodies; the larger the distance, the larger is the value of G. In other words, there is always a short range repulsive force acting between two bodies. As soon as they get closer, it comes into effect making the inverse square law invalid for that distance.

Long's finding has yet to run through the gauntlet of subsequent experimental verifications. But, if it stands the test, what repercussions will it have? It bears serious implications on quantum theory of gravity, on the interiors of the earth and the sun, to quote a few.

D.M.S.

nto each other as in atom bombs.

The special theory explained the neative result of the Michelson-Morley experiment. The concept of the inerchange of mass and energy also explained how the sun and other stars an continuously eject large amounts of energy—one of the riddles to the classical theory.

General theory of relativity

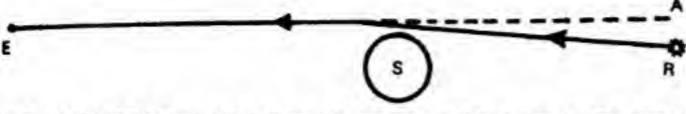
The Special theory of relativity applies only to those reference frames which are in uniform relative motion with each other; in other words, those which have no acceleration relative to each other. However, actual motion in this universe is complicated. In 1916, Einstein developed his general theory of relativity to take account of accelerated motions. From it emerged a few more important concepts and the correct explanations of a few unsolved problems.

Suppose we are in a lift which is closed, and we cannot see outside. Suppose the cable of the lift breaks and it starts falling down toward the earth. Inside the freely falling lift, we will feel no acceleration do to gravity. If we take a ball in our hand and leave it, it will float and with appear to be stationary relative to us. Actually it is falling with the same velocity and acceleration.

On the other hand, suppose we ar in a lift which is far away from a stars, in the intergalactic space, when there is no gravity and suddenly som unknown force starts pulling our li upwards with a constant accele ration. In such a situation w will feel that the floor of the lift attracting us. If then we try to jump we will "fall down" on the floo In this manner, Einstein showed the gravity is equivalent to acceleration The three dimensions of space an one dimension of time had to b fused to give rise to a four-dimer sional space-time continuum, which is distorted by the presence of matte The natural path of a body in th space-time continuum is called geodesic. So the mysterious concer of "action at a distance" vanishes ar we say that every object, including a ray of light, moves along "geodesic" in the space-time cont nuum provided it does not underg collision with another body and not acted upon by electromagnet forces. The geodesic in a region w



How curious that drop of an applicaught Newton's attention but growt of a plant upwards against earth' gravity did not intrigue him at all.



ig. 3. A ray of light from a star R passing near the sun S is deflected. The star, as observed on the earth E, appears to be at a displaced position A

that region. Thus, a planet moves ound the sun in a particular orbit of because it is attracted towards he sun but because the path happens be a geodesic in the presence of he sun and other masses of the niverse. Whether it is a planet noving round the sun, a star moving a the galaxy, or a ray of light coming rom a star to the earth, each object moving along a geodesic.

It has not been possible to take count of electromagnetic phenomeon in a manner similar to that adoted for gravitational phenomenon.
instein himself spent many years
f his latter life to construct a unified
eld theory in which both gravitaional and electromagnetic field
yould be accounted for by a new
eometry, but without much success.

Einstein himself suggested three xperimental tests for his general heory:

1. The precession of the perihelion of the inner planets. We have earlier een that there is a discrepancy of bout 43" of arc per century in the observed precession of the orbit of dercury and that calculated on the easis of classical physics. The difference has now been explained by the eneral theory. Table 1 lists these values for some of the inner planets.

2. The deflection of a light ray

oming from a distant star passes by he sun, its path is defected due to he sun's gravitational field, as shown in Fig. 3, just as a projectile follows curved path in a gravitational field. According to Einstein's theory, this deflection comes out to 1.75".

In order to observe a ray of light coming from a star and passing near he sun, it was necessary to wait for total solar eclipse. Such an eclipse was to occur in 1919 and a team of scientists headed by the British physicist A.S. Eddington studied 12 stars in the neighbourhood of the sun in Africa and South America. They found that the deflection of a ray of light agreed with Einstein's predicted value. Since then, about 380 stars have been studied during solar eclipses. The results obtained are given in Table 2.

Recent developments in radio astronomy have made it possible to measure the deflection of radio signals passing near the sun with a greater accuracy. Moreover, one does not have to wait for a total

solar eclipse for these measurement. The results, moreover, confirm the general theory of relativity.

ding to Einstein's theory, the frequency of the radiation emitted or absorbed by an atom in a gravitational field is smaller than that by a atom in free space. If we observe the visible spectrum of familiar atom (such as hydrogen) coming from massive star, the familiar spectral lines will appear to have shifted to wards the red end (longer wavelength of the spectrum. This has been observed and experimentally confirmed.

According to the general theory of relativity, the sun's gravity do reduce the speed of propagation of any signal passing by it. Recently a group of scientists at the Jet Propusion Laboratory, California Institut

Table 1. Comparison of theoretical and observed centennial precession of planetary orbits

Ness	Barretoria	Precession (seconds of arc/century)		
Planet	Revolutions per century	Observed	Calculated	
Mercury	415	43.11+0.45	43.03	
Venus	149	8.4 ±4.8	8.6	
Earth	100	5.0 ±1.2	3.8	
Icarus (an asteroid)	89	9.8 ±0.8	10.3	

Table 2. Deflection # of a light ray grazing the sun observed during total solar eclipses

Date	Site	No. of stars studied	(in seconds of arc
			, , ,
May 29, 1919	Sobral	7	1.98±0.16
A STATE OF THE STA	Principe	5	1.61±0.40
Sept. 21, 1922	Australia	11-14	1.77±0.40
2010, 50, 302	Australia	18	1.42 to 2.14
	Australia	62-85	1.72+0.15
	Australia	145	1.82±0.20
May 9, 1929	Sumatra	17-18	2.24±0.10
June 19, 1936	U.S.S.R.	16-29	2.73±0.31
	Japan		1.28 to 2.13
May 20, 1947	Srezil	51	2.01±0.27
Feb. 25, 1952	*wan	9-11	1.70±0.10

of Technology, U.S.A., measured the time delays of radar signals sent from the earth to the artificial satellites, afariner 6 and Mariner 7, and back to the earth during the period Marchune, 1970, when these satellites were sear superior conjunction. The best results were obtained on April 28, 1970, when the radar signals passed very close to the sun. The results agree within 5% with the values oredicted by the general theory.

The future

No theory is complete. In spite of its successes, there are, however, ome threats to the structure of heory of relativity. One of the hreats comes from the observation hat the 'universal constant of graviation' G is not really a constant, but

decreases in time at a very slow rate. Recently, K.P. Sinha and C. Sivaram of the Indian Institute of Science, Bangalore, have suggested that there are two gravities—one, a strong gravity measured by a coupling constant Gr, and the other a weak gravity measured by the Newton's constant G. The strong gravity Gt. plays an important role in atomic properties of matter and remains unchanged, whereas the weak gravity G changes in time. According to Sinha and Sivaram, the two gravities (G and Gt) were equal to each other at the moment of the creation of the Since universe. then Gr has remained unchanged, whereas G has decreased in time. Further experimental observations will decide the future course of the theory.

Further reading

- Jammer, M., A Concept of Force Harvard University Press (1970)
- Holton, G., Thematic Origins of Scientific Thoughts, Harvar University Press (1973).
- Russell, B., The ABC of Relativity, George Allen & Unwir London (1958).
- Shapiro, I.I., et al., Fourth Ter of General Relativity: Nev Radar Results, Phys. Rev. Letter 26, 1132 (1971).
- Weinberg, S., Gravitation and Cosmology, John Wiley and Sons New York (1972).
- Sivaram, C., and Sinha, K.P. "1-gravity and Spinors in General Relativity", Lett. Nuovo Cimente 13, 357 (1975).

LETTERS (Continued from page 389)

Turtles

Sir, In the article, It is the turn of he turtles (S.R. Feb., 1976), the uthor says that a turtle which is aid to have been grown by Capt. Cook in 1777 A.D. is still living in he Tongo Island. Again, the author vrites that turtles and tortoises are upposed to live for 300 to 400 years. t is an absurd calculation. Guinness Book of World Records (1974 Edn.) r any other book does not say that turtle or a tortoise can live for 300 r 400 years. Actually, Capt. Cook's urtle referred to by the author died n May 19, 1966. The longest uthentic recorded age of a tortoise s 152 years. It's a male Marion's ortoise (Testudo sumeirii).

G.M. NATARAJAN

Deptt. of Natural Science

Rajah Serfoji Govt. College

Thanjavur-613005

Heterocysts

Sir, Apropos of Biochemistry of heterocysts and their role in nitrogen fixation (S.R. Feb., 1976), I wish to point out how the transformation of normal undifferentiated vegetative cells into heterocysts takes place. Many workers have studied the role of heterocysts in nitrogen fixation. They have concluded that in addition to the nitrogenase enzyme there are some nitrogen fixing genes (nif genes) also located inside the heterocysts which too are involved in nitrogen fixation.

PRASANNA K. DAS

Deptt. of Botany

D.A.V College

Koraput (Orissa)

Suggestion

Sir, Thank you for Biomembrane

(S.R. Jan, 1976). Why don't you publish an article on schizophrenia elucidating its cause, orientation and cure?

> FRAVISH VISWANATHAN Ghaziabad (U.P.

> > П

Sir, I am a regular reader of S.R. and find it quite absorbing.

I would like you to publish articles on sub-atomic particle like mesons, antiprotons, positrons charmed particles, etc. These article will be quite informative and lessue the burden of the students of gather ing information from various books

> P.V. KRISHNA REDDY Gogineni Hoste Andhra Loyola College Vijayawada-52000k



EFFECTS OF NUCLEAR RADIATIONS ON POLYMERS

Nuclear radiations inducpolymerisation and also produce changes in polymeric substances. The effects are of great technological importance

Various types. Charged particle adiations are alpha-rays (helium uclei), beta-rays (energetic electors) and protons, etc. Neutrons re neutral particles, and gamma ays and X-rays are electro-magnetic radiations.

Sources used for gamma-irradiaon include natural (radium) or articially produced radioisotope (coalt 60) and electronic machines. In machine sources, particles (protons, lectrons, etc.) are accelerated to high mergetic streams. The important purces are given in Table 1.

ffect of radiation

When radiations interact with atter in molecular form, certain fects are produced which are mainly hemical in nature. These effects

depend on the nature and energy of the radiations on the one hand and the nature of the irradiated substance on the other.

The basic mechanism of interaction of radiation with matter occurs through the interchange of energy. Irradia effects are:

Excitation. An electron is raised to a higher energy level leading to the formation of an excited atom or molecule.

lonisation. An orbital electron is removed from an atom in the substance and forms an ionised molecule or atom and a free electron.

Atomic displacement. An atom may be displaced from its normal position in a solid substance forming defects.

Radiation capture. The incident radiation may be captured by an atomic nucleus resulting in nuclea transformation.

Scattering. The radiation may be scattered by an atom or nucleus followed by emission of secondar radiations.

The effect produced by irradiation depends upon the amount of radiation absorbed, that is, the dose. Of the different types of dosimeters physical dosimeters work on the principles of formation of colour development of heat and ionisation etc., whereas chemical dosimeter measure the chemical change produced, for example, change of concentration in a ferrous sulphas solution.

Polymerisation by irradiation

A polymer is a large moleculouilt up by the repetition of small

iss Bohidar is research fellow in the Department of Chemistry, Utkal University (Orisea)

Table 1. Radiation sources

Radioisotope sources	Radiation	Machine sources
Radium,	Gamma-rays	Van de Graff Accelerator
Cobalt-60,	Gamma-rays	Cyclotron
Polonium-210,	Alpha-rays	Linear accelerator
Radon,	Alpha-rays	

imple, chemical units. The repeatng unit, the monomer, is the building block of the huge molecular structure of the polymer. In some cases, repetition of the monomer unit is linear forming a long-chain polymer, while in others the monomer units may be interconnected or crosslinked to give a three-dimensional network polymer. Moreover, all the monomer units in the polymer chain may be identical as in homopolymers, or the chain may consist of two or more types of monomers forming copolymers. The length of the polymer chain is specified by the number of repeating units which s known as the degree of polymerisaion. Examples of this are given in Table 2.

Polymerisation of monomers can be brought about through irradiation. The reverse phenomenon also occurs when a polymer is irradiated, that is, upon irradiation a polymer may break up into smaller units. Both these processes are of indusrial interest.

During early studies of polymerisaion, it was found that when methyl methacrylate, styrene and vinyl cetate were irradiated high polyners were produced. This radiation-induced polymerisation is a chain reaction in which the primary process of ionisation or excitation is followed by chemical changes. A monomer is converted into a polymer mainly through three stages, namely initiation, propagation and termination of the chain. The role of the interacting radiation is confined only to the initiation stage following which the reaction proceeds independently.

Mechanism. Polymerisation can be initiated either by a radical or by an ion. The interaction of radiation with molecules primarily produces ions and excited molecules, but most of the polymerisation processes proceed through the radical mechanism. These free radicals are formed indirectly from the irradiated excited molecules and ions. When an unsaturated molecule is irradiated, it is believed that a free radical is formed at one end and a carbonium ion at the other

An anion as well as a free radical may also be formed by electron capture in an unsaturated compound.

The three basic steps in polymerisation already considered, namely,

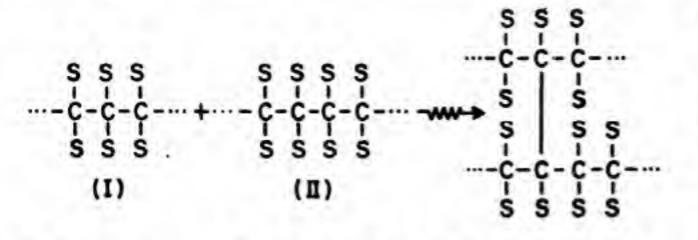


Fig. 1. Radiation-induced crosslinking; I and II are polymer molecules, S may be a side-chain or a hydrogen atom

initiation, propagation and termina tion can be outlined as follows:

Initiation: M — VV

(Monomer) (free radical) Propagation: $M+R \rightarrow RM$

 $RM.+M\rightarrow RMM$

RM·a+M+RMMM...M·a+

Termination: In homogeneous liquid phase, termination occurs by the mutual interaction of two growing polymer radicals. This take place either by combination (dimerisation) or by disproportionation which consequently produces a 'dead' polymer.

$$RM_{n'} + RM_{m'} \rightarrow P$$

The above mechanism success fully explains radical polymerisation in the liquid phase. There is another possibility, namely, that o ionic polymerisation in the liquid phase. The mechanism for this can be represented as follows:

In this process, instead of formation of free radicals, ions are formed by the action of radiation. The positive ion can initiate polymerisation by transferring a proton to a monomer or by adding onto another monomer molecule.

Propagation: M++M+→MM+

 $MM...M_{m}^{+}+M\rightarrow MM...M_{m+1}^{+}$ Termination: Termination follows

this ionic propagation and may occur by charge or proton transfer. Hence in presence of an impurity X, the propagating chain may be terminated as follows:

 $M \dots M^{+}_{m+1} + X \rightarrow M \dots M_{m+1} + X^{*}$

A study of radiation-induced polymerisation has shown that numerous monomers polymerise upon irradiation even in the solid-state. Important examples of those monomers are vinyl acetate, isoprene, acrylonitrile, acrylamide, etc.

The most important factor in solid-state polymerisation is the precise structure of the solid. Crystalne and amorphous states show mared differences in this connection. o, even when crystalline and amorhous forms of the same solid are radiated under identical condions, pronounced differences in olymerisation behaviour occur. In rystalline solids, defects play an nportant role in polymerisation. some kind of defect is present in he monomer crystal, it favours the nobility of molecules and increases he rate of polymerisation. In some ther cases, defects present in the rystal decrease the rate of terminaion consequently increasing the olymerisation rate.

The mechanism of radiation-indued polymerisation in the solid phase as not been established with cerainty. From available evidences, it eems that both free-radical and iotic mechanisms occur depending upon the monomer and the condition of irradiation.

The benefits obtained from this process can be summarised as folows. The polyethylene formed by rradiating ethylene has got higher nelting point than the polyethylene produced by other device. Polymehyl acrylate which is obtained from rradiated methyl acrylate exhibits nigher (rubber-like) density than conventional polymer. On analysing the overall results obtained in polymers produced by irradiation, it has been observed that net density of such polymers is definitely higher than that of conventional polymers. Such an observation no doubt is of considerable importance in major helds of scientific developments. Now it has been confirmed that nearly all organic compounds can produce polymers upon irradiation depending upon the availability of reactive group in parent compound or in one of its degradation products.

Effect of radiation on polymers

The effect of radiation on polymers is of great biological and industrial interest which has led to out-

CROSSLINKED MOLECULE

Fig. 2. Mechanism of crossinking

standing developments in science and technology.

When radiation interacts with polymers, the macromolecules undergo irreversible physical and chemical changes to form different types of products. The main chemical changes are crosslinking, degradation, gas formation, and double bond formation.

Crosslinking. If a vinyl polymer (-CH₈-CH₈-)_a is irradiated, it under goes crosslinking to form [-CH₈ CH-]_a. This process is analogous to dimerisation. Crosslinking (Fig. 1) can be followed by increase in the viscosity, molecular weight and the degree of branching.

The mechanism of crosslinkin (Fig. 2) involves the rupture of the

Fig. 3. Machanism of degradation; I is a polymer, II and III are degraded fre radicals, IV is the represented product

Fig. 4. Block copolymerimtion

de chain or removal of a hydrogen dical. It has been suggested that sually a hydrogen atom from one nolecule (i.e., a hydrogen radical) moves another hydrogen atom om a neighbouring molecule giving se to two radicals. These two ree radicals react with each other to orm a crosslinked molecule. Those olymers having hydrogen atom as a ubstituent in the main chain such polyethylene, polypropylene, olyvinyl chloride, polyacrylonitrile, olystyrene, natural rubber, etc., unergo predominant crosslinking upn irradiation.

This process of radiation-induced rosslinking can be compared with the vulcanisation of rubber where a sulphur atom becomes attached to wo rubber molecules and forms a tak between them.

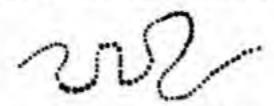
Polymers having less crosslinking ensity exhibit rubber-like elasticity hereas highly crosslinked polymers how more elastic modulus. Consequently, they are hard, brittle, and infusible as are phenol-formaldehyde resins.

Degradation. Upon irradiation, some polymers degrade into smaller units and other products. As irradiation proceeds, the huge polymer molecule becomes smaller and consequently the material loses its polymeric property.

Degradation predominates in polymers in which there is no hydrogen but some other substituent on the carbon atom, bearing a side chain, as in case of vinyl polymers. The fragmented species have the molecular formula [CH₁-C(CH₂) R-]_n. This is because the methyl group introduces a steric (relating

to spatial arrangement of atoms strain into the molecule as a result of which the —C—C— bond in the main chain is weakened. The process terminates in a main chain scission

Due to degradation of polyme there is a reduction in the average molecular weight. The mechanism of radiation-induced degradation ca be represented as shown in Fig. : It involves ionisation and excita tion of irradiated molecules. The fractured products are unstable an hence undergo molecular rearrange ment to stabilise the new en Substances groups. such ! polyvinylider polyisobutylene, chloride, cellulose, etc., unders severe degradation upon irradiatio



BLOCK COPOLYMER

Juny.

GRAFT COPOLYMER

Fig. 5. Diagrammatic representation of block and graft copolymers

Fig. 6. Graft copolymerisation

It may be said that none of the roposed mechanism can' explain etails of the actual reaction in high olymers because the effects produed by radiation are largely influened by many circumstances.

There are secondary effects prouced upon irradiation of polymers. lighly unsaturated polymers, such s natural rubber, tend to become ess unsaturated upon irradiation. he reverse phenomenon, i.e., increaed unsaturation is also observed in ertain polymers. Another radiationnduced effect has been reported in hich a conjugated system of double onds is developed in a polymeric ystem. Such a process accounts for he development of colouration in cerin polymers when exposed to radiaon. During irradiation of polyners some trapped free radicals may lso be formed which produce colourtion. For example, polyvinyl hloride becomes coloured during radiation, the colour being yellow, reen or red according to purity. he irradiated plastics also exhibit change of colour.

Another important chemical hange produced upon irradiation the formation of gas. The amount f gas formed depends on the nature f the polymer and also on dose. imperature, type of radiation, etc. or example, irradiated polyethylene volves hydrogen gas whereas polyobutylene produces methane, isoutane and hydrogen. Main gases volved from irradiated polymethyl ethacrylate comprise of carbon onoxide, carbon dioxide, hydrogen d methane.

Block and graft polymerisation

Block polymerisation. If a polymer which commonly degrades on irradiation is irradiated in the presence of a vinyl monomer, the chains of the vinyl polymer grow from the ruptured ends of the main chain. The effect of radiation is to break the homopolymer chain producing free radicals at the ends. These free radicals react with each other to form block copolymers having a definite arrangement of the two different monomer units (A,B). Two cases of block copolymers are shown in Fig. 4.

Graft polymerisation. Polymers which undergo cross-linking on irradiation produce graft copolymers in presence of another monomer unit. Interaction of radiation with the polymer chain involves rupture of the side chain. Hence, the process results in the formation of a free radical on the main chain which initiates the side chain polymerisa-

tion of an added monomer. simple chains of block and graft copolymers can be represented diagrammatically as in Fig. 5. The mechanism can be represented in outline as shown in Fig. 6.

Formation of a graft copolymer by irradiation may also be accompanied by the formation of considerable amount of homopolymers of B (i.e., BBBB). Hence, the monomer unit B must be present in less quantity for successful graft polymerisation. The dose required for grafting may be very low, since each radical can initiate a long polymerisation chain.

There is another method for producing graft copolymers which is commonly known as the peroxide technique of grafting. The process of grafting involves the irradiation of polymers in air which consequently forms a peroxide group. When a peroxidised polymer is heated in vacuum in the presence of a mono-

Fig. 7. Mechanism of peroxide technique of graft copolymerisation

MONOMER UNIT

Ethylene

Vinyl chloride

Methyl methacrylate

Styrene

CORRESPONDING POLYMER

Polyethylene

Polyvinyl chloride

Polymethyl methacrylate

Polystyrene

her, free radicals are produced on the polymer chain due to the deomposition of peroxide group. The tree radicals formed will initiate the polymerisation of the added monomer giving a graft copolymer. This process is more advantageous due to the fact that the grafting itself can

be carried out at any time away from the radiation source, so that the rise of homopolymer (BBBB.....) for mation is very much reduced. The diation doses used in this method production of graft copolymers are uite small. So, the general properes of the backbone polymer are ot affected to any marked extent and he form of original polymer may be enserved in the process. The mehanism of peroxide technique can be represented as shown in Fig. 7.

Graft polymerisation has certain dvantages: (i) there is an increase the softening point of acrylonitrile hen it is grafted on polyvinyl chlode; (ii) when methyl methacrylate grafted onto polyethylene it forms harder, transparent and amorphous roduct, (iii) acrylamide grafted onto olyethylene gives a hydrophilic urface which is printable; and (iv) tyrene can be grafted onto polythylene and the resulting graft polyner is a semipermeable membrane sed for separating salts from soluon (dialysis). This membrane is lso useful for water purification. n textile industries, static electric harge is developed on synthetic bres during weaving which produces ertain undesirable effects. Graft olymerisation can reduce the freshly eveloped static electric charge and lso improve the uptake of dyes in extile fibers. Large scale research work has been carried out in this

Radiation protection

ield.

Polymers have also been found seful as radiation protecting materials. Various methods have been levised to increase the radiation staility of polymers mostly plastics nd elastomers so that they undergo he least possible chemical change when exposed to radiation. The esic principle of these methods is he dissipation of incident radiaion energy to some other chemical roup in the molecule (internal proection) or to some other added ompound (external protection), as result of which the main polymer hain remains unaffected. Polytyrene affords internal protection to

radiation as the radiation energy is dissipitated by its benzene ring structure. On analysing the radiation stability of several chemical groups in polymers, it has been established that the benzene ring offers maximum resistance to radiation energy.

In external protection of polymers, the additives (referred to as protectors) operate through energy transfer, that is, they absorb the incident radiation from the polymer leaving an unaltered polymer chain. These additives in turn may dissipitate the absorbed energy without undergoing any permanent chemical change or be modified in which case their reactivity ceases. Secondly, the additive may repair the radiationinduced damage in the polymer through radical-radical reactions inhibiting the formation of polymeric free radicals and subsequent crosslinking and degradation.

The effect of radiation on polymers is of great importance. Radiation effects on the most widely used polymers such as plast tics, rubbers, synthetic fibers, etc. have attracted the attention not only of industry but also of research workers. Work on polymers and polymerisation is currently being done at the Central Leather Research Institute, Madras and the India: Association for the Cultivation of Science, Calcutta. Much progress in this field is foreseen in the neafuture.

Further reading

- Charlesby, A., Atomic Radiational Polymers, Pergamon President Oxford, 1960
- Kircher, J.F. and Bowman, R.I. (Eds.), Effects of Radiation of Materials, and Component Reinhold Publishing Corp., Ne York, 1964.
- Swallow, A.J., Radiation Chemistry, Longman, London, 197.

In accordance with the latest instructions of various examining bodies and based on latest trends in examinations

FOR SURE SUCCESS

Read

Arun's Objective & Short Answer Type Questions in

1.	Physics	Rs. 4.50
2.	Chemistry	Rs. 4.50
3.	Mathematics	Rs. 4.50
4.	Biology	Rs. 4.50
5.	English	Rs. 4.50
6.	History	Rs. 4.50
7.	Economics	Rs. 4.50
8.	Commerce	Rs. 4.50
9.	General Knowledge & I. Q.	Rs. 3.00
10.	Civics	Rs. 4.50

Published by :

YOUNG MAN & CO.

888 NAI SARAK, DELHI-110006

Copies available with all the leading booksellers or send your order with an advance of Rs. 5.00 by M.O.

B. PAL and J. J. GHOSH

THE year 1971 marked the fiftieth anniversary of the iscovery of insulin, a much celerated event throughout the scientific orld. Nineteen seventy-three marked the fiftieth anniversary of the iscovery of glucagon. The contast in the history of these two formones originating from the juxta-osed cells in pancreas, could not be more striking.

Insulin was well accepted as a hornone even before its demonstration n 1921 by F.G. Banting and C.H. Best of the University of Ontario Canada), which was heralded as a najor breakthrough in biomedicine. On the other hand, when two years ater J.R. Murlin and associates of he University of Rochester (U.S.A.) eparated glucagon from insulin and uggested its possible role as a glucoegulatory hormone, they received ttle notice for their efforts. The ramatic impact of insulin discovery n the treatment of diabetes overhadowed the importance of glucaon. In fact, for most of the ensuing ecades the hormonal status of lucagon was questioned, and not ntil the 1940s did it begin to elicit he interest of the researchers. Until he late 1960s, the importance of lucagon as a physiologic regulator nd as a contributor to or as a cause f disease seemed doubtful.

The physiologic functions of lucagon are now fairly delineated. t has been realised at present that lucagon, like insulin, is extremely mportant in the moment-to-moment ontrol of the homeostasis of glucose, mino acids and fatty acids. Contary to the notion that diabetes nellitus is absolutely due to the lack f insulin, research of the last decade as underlined the contribution of lucagon abnormality in this ydrome.

Origin and structure

Insulin is secreted by the β—cells and glucagon by the a—cells of the dets of Langerhaus in the pancreas. These are juxtaposed cells elaborating



Both glucagon and insulin, the two hormones from pancreas participate actively in the regulation of glucose, fatty acid and amino acid metabolism. Insulin may be regarded as a hormone of energy storage, whereas glucagon is viewed as that of energy release

the hormones, and are distinct from the acinar cells in the pancreas responsible for the secretion of digestive enzymes. Both insulin and glucagon are oligopeptides, the former comprising of 51 and the latter of 29 amino acid residues. The amino acid sequence of insulin is given in Fig. 1. Glucagon has been shown to have the following amino acid sequence:

His-Ser-Glu(NH₂)-Gly-Thr-Phe-Thr-Ser-Asp-Tyr-Ser-Lys-Tyr-Leu-Asp-Ser-Arg-Arg-Ala-Glu(NH₂)-Asp-Phe-Val-Glu (NH₂)-Tyr-Leu-Met-Asp (NH₂)-Thr

Glucagon was called the hyperglycemic-glycogenolytic factor (H-G-F), a term that appropriately described some of its actions. The name 'glucagon' was given to the

hormone by its discoverers, and means mobiliser of glucose. I addition, glucagon has been decisivel shown to possess gluconeogeni (gluconeogenesis means productio of glucose in the body from nor carbohydrate scurce) and lipolyti activities. All these effects of gluca gon are in direct contast with thos of insulin-a hypoglycemic, glycogo nic, antigluconeogenic and antil polytic hormone. Whereas insuli may be regarded as a hormone of energy storage, secreted mainly during the influx of exogenous nutrients, glu cagon may be viewed as a hormon of energy release mobilising endoger ous stores of energy-yielding nutr ents. In other words, insulin ma principally be considered as a ho

Dr. Pal was formerly a Research Associate in the Department of Medicine, Univ. of Rechester School of Medicine, N.Y., U.S.A.;
Dr. Ghosh is Prof. and Head, Deptt. of Biochemistry, University College of Science, Calcutta

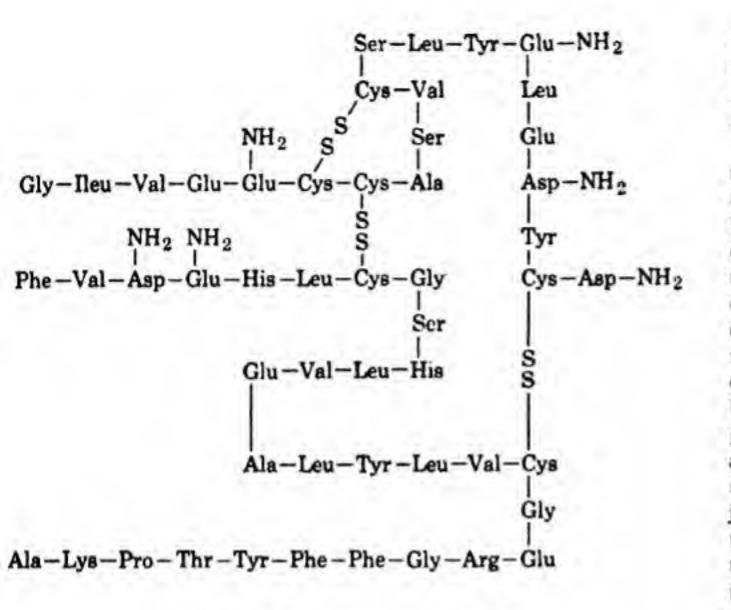


Fig. 1. Amino acid sequence of insulin

none of anabolism, while glucagon s a hormone of catabolism.

sihormonal control of nutrient disosition

The juxtaposed α— and β—cell air may, therefore, be looked upon s a single bicellular functional unit. hrough the diametrically opposite ctions of its hormones, it controls he movement of glucose, amino cids and fatty acids into and out of he cells throughout the body in ccordance with the energy demand nd the exogenous energy supply. in optimum rate of storage of ingesed glucose in the form of glycogen, hereby the blood glucose level is rought down to normal level after carbohydrate meal (Fig. 2), requires prompt and adequate release of isulin, the 'hormone of energy orage' and a rapid suppression of e secretion of glucagon, the 'horone of energy release'. According Roger H. Unger of the University Texas, Southwestern Medical chool, Dallas, Texas (U.S.A.) (1971),

when the two types of islet cells respond normally, the concentration of ingested glucose in extracellular fluid is remarkably confined to a narrow range, if we consider the wide variation in food intake from fasting to feasting. We have to take a note that if glucagon does not decline during the period of increased insulin secretion, the quantity of insulin released would not prompt as rapid a glucose storage, and glucose disposal would be delayed. Reduced glucose tolerance characteristic of the diabetics may well be a consequence of the combined failure of insulin to rise appropriately and of glucagon to come down during hyperglycemia.

In starvation when survival requires careful rationing of endogenous stores of energy, a pattern of hormone secretion activity is observed opposite to that after a carbohydrate meal (Fig. 3). Secretion of glucagon rises whereas that of insulin falls, thus favouring gluconeogenesis for energy supply. It is remarkable that

these changes are maximum during the first week of starvation who gluconeogenesis has been found to be maximum.

Increased availability of free fat acids (FFA) appears to have a qual tative, if not strictly quantitativ bihormonal response of the isl cells similar to that of carbohydra Hyperlipacidemia pro ingestion. duced by infusion of a triglyceric emulsion is associated with a mode rise in insulin and a decline in gli cagon. Hypolipacidemia induce by nicotinic acid results in elevate glucagon secretion. Therefore appears that energy-providing sul strates suppress glucagon secretio just as they stimulate insulin secre tion. It is logical to surmise that i the basal fasting state, the a-ce is "set" to secrete glucagon at a hig rate, just as the B-cell is "set to secrete insulin at a low rate; th influx of energy-yielding nutrient such as glucose and FFA, inhibits th a-cells and stimulates the β-cells

The bihormonal response to a ris of plasma amino acids differs in situ ations. In normal individuals, th ingestion of a beef meal is associated

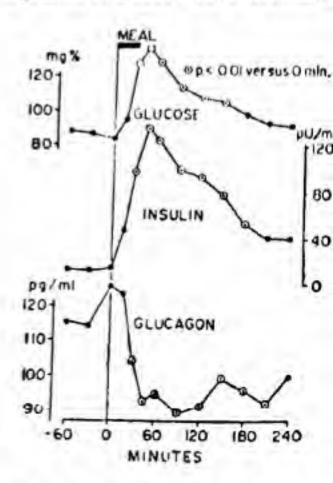


Fig. 2. Response of plasma insulin, gluci gon and glucose concentration to carbohydrate meal in norms subjects

ot only with an increase in the cirulating insulin but also with a draatic rise in plasma glucagon. In iew of the opposite roles played by ne two hormones, the observation is mewhat surprising. However, ther effects of insuln will help larify the situation. Insulin faciliites the incorporation of ingested mino acids into tissue proteins. Moreover, it helps the transfer of lucose from the extracellular comartment to the intracellular compartnent. This transfer is presumably ecessary to provide energy for proein biosynthesis. Therefore, hyperminoacidemia may, in a sense, be egarded as a form of glucose need in ormal circumstances. Release of lucagon apparently prevents hypolycemia incidental to insulin secreion during hyperaminoacidemia. This view is supported by several vidences. First, contrary to proein meal alone the infusion of lucose during a protein meal suppesses glucagon secretion in normal ondition. Secondly, the results of rginine infusion study give credence o this view. A very dramatic rise n plasma glucagon during the first ive minutes of infusion of arginine at the rate of 11.7 mg/kg body wt. per minute) and reaching peak at 40 ninutes is observed in normal persons n association with a parallel rise in nsulin (Fig. 4). Despite a brisk typerinsulinemia, a prompt rise in blood glucose concentration, averagng 15 mg/100 ml, is uniformly obserred, presumably as a consequence of increased level of glucagon. However, similar infusion of argininenduced hypoglycemia in a patient with glucagon deficiency. Thirdly, he central role of alanine in glyoneogenesis is consistent with the iew outlined above.

Although most dietary amino cids are gluconeogenic, according to Philip Felig of the Yale University School of Medicine, New Haven, Conn. (U.S.A.), alanine is the principal endogenous precursor

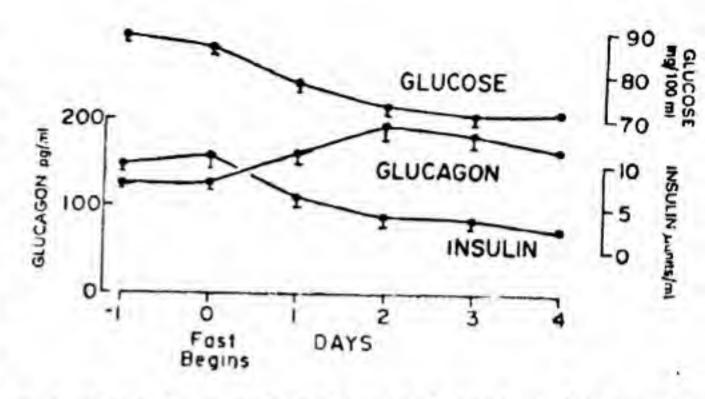


Fig. 3. Morning glucagon, insulin and glucose levels in plasma of volunteer before and during three to four days of total starvation

accounting for most of the glucose produced from amino acids during starvation (alanine is formed in the muscle during starvation at a high rate by transmination of pyruvate with other amino acids, which is subsequently transported to liver by blood stream for production of glucose. Reference: The Glucose-Alanine Cycle, Philip Felig, Metabolism, Vol. 22, pp. 179-207, 1973).

Glucagon concentration rises by approximately 50 per cent during the first few days of starvation, and this increase coincides with the period of maximum gluconeogenesis and the maximum extraction of alanine by liver. The administration of alanine to fasting dogs was associated with a very brisk rise in glucagon but no change in insulin secretion, a pattern that would encourage gluconeogenesis. However, when dogs were infused with glucose, making gluconeogenesis unnecessary, the administration of alanine was accompanied by a major rise in insulin but only a negligible increase of glucagon, a response that would minimise the rate of gluconeogenesis and perhaps direct the alanine into the muscle cell. Therefore, it appears that the relative responses of the two hormones may partially influence the fate of exogenous amino acids either towards gluconeogenesis or protein biosynthesis and this bihormonal response is

conditioned by prior and current carbohydrate availability.

In subjects whose prior intake of carbohydrate has been sufficient, th concentration of insulin in bloo relative to glucagon rises after protein meal, favouring the incom poration of the ingested amino acid into protein. In fasted or carbo hydrate deprived subjects, the revers is true. This is further exaggerate after a protein meal owing primaril to lack of insulin secretion. Th secretion of glucagon without cor insulin release wou acclerate the direction of the ingeste amino acids into gluconeogenic patl ways. In health, the use of endoger

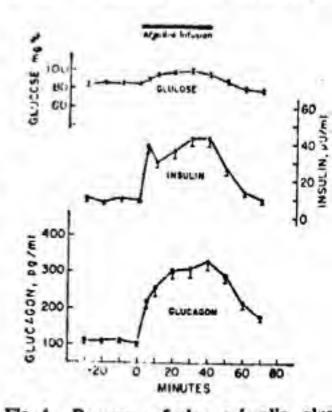


Fig. 4. Response of plasma insulin, gluc gon and glucose concentration the infusion of arginine in norm persons

Table 1. Need for endogenous glucose production vs. fasting I/G ratio

Experimental situation	I/O
Starvation	0.4
Low carbohydrate diet	1.8
Balanced diet	3.8
Glucose infusion	16.0

us amino acids for glucose producon, with wastage of nitrogen in the orm of urea, is probably minimum xcept when alternative sources of lucose production are not available. The bihormonal response to intraenous administration of potassium dogs resembles to that of a protein neal in normal individuals, namely, parallel rise in both glucagon and kaliogenic sulin. The esponse is regarded as an important efense against hyperkalemia (rise of lasma potassium, which in extreme ases may end in cardiac arrest), since its absence a large amount of exgenous potassium is not temporariaccomodated inside the cell, pendig excretion by kidney. Potassium iduced hyperglucagonemia, on the ther hand, appears to serve as a cans of counteracting hypoglycemia ncidental to insulin secretion. When otassium is given together with lucose, glucagon response is constently blocked. It has been proosed that the islets of Langerhans nay provide an instant buffer to acute hanges in plasma potassium.

nsulin glucagon molar ratio (I/G)

The long prevailing notion that inulin exerts certain metabolic actions
nd that in its shortage, as in
iabetes mellitus, it produces the
dverse effect, does not hold true.
It is now known that it is not
ne absolute blood level of insulin,
ut the insulin-glucagon molar
atio (I/G) in the blood that deternines the moment-to-moment
omcostasis of glucose, amino acids
and fatty acids. Several investigaors have clearly demonstrated the

opposing actions of insulin and hepatic glucagon upon glucose balance and adipose tissue balance. It is, therefore, evident that by varying the relative concentration of glucagon and insulin, the a-and β-cells possess the biological capability of controlling not only the balance of glucose across the liver and of fuel across the adipose tissue, but also of directing the disposition of gluconeogenic amino acids, of both endogenous and exogenous origin, either into glucose production or into protein synthesis in accordance with the prevailing need. A rise in I/G would promote storage of ingested nutrients of all types; endogenous glucose and free fatty acid production would be inhibited, and protein biosynthesis would be favoured. On the other hand, a fall in I/G would favour the mobilisation of stored nutrients; increased hepatic glucose production from glycogen and from available amino acids would occur at the expense of protein synthesis, nitrogen balance would shift towards the negative with increased production of urea, and the release of free fatty acids and glycerol from adipose tissue would also increase. In other words, a high insulin-glucagon ratio could favour nutrient storage, while a low insulin-glucagon ratio would favour mobilisation of nutrient stores and protein catabolism.

There is now considerable evidence that the molar ratio of insulin to glucagon is inversely related to the prevailing need for endogenous glucose production. This point is illustrated in the results given in Table 1,

Diabetes

LL the food we eat consists of A three basic constituents namely carbohydrates, fats and proteins. All these are broken down into smaller components by the digestive system with the help of chemical substances called enzymes and harmones that are produced by the body. Carbohydrates (or starches) which form the bulk of our food are borker down finally into glucose. Glucose provides energy to the body However, tissues themselves cannot utilize glucose. For the uptake of glucose by tissues and its subsequent oxidation, a harmone called insulin is required.

Insulin is secreted by the endocrina part of a gland cell in pancreas In the pancreas there are microscopic "Islands" called islets of Langer hans which are seats of production of insulin. Relative or absolute la k of insulin in the body, leads to Diabetes mellitus or simply diabetes. In this condition the glucose cannobe utilised by the body and hence the blood level of glucose goes very high and it also appears in the urine

Diabetes mellitus has been known to humanity since ancient times In India, the ancient system of medicine Ayurveda was aware of thidisease and named it "Madhumeha" because of the honey-like sweetnes of urine of the afflicted person.

The role of pancreas as the under lying cause of diabetes was recognised in 1886, when Minkowesk and Ven Mering produced diabete by total removal of pancreas in dog. 35 years later in 1921 Fredric Banting and Charles Best isolate insulin. It was only in 1955 that Sanger demonstrated the amin acid sequence of insulin molecule

in which situations are listed i

N.

production after an overnight fast in normal persons. After an overnight fast of a balanced diet, when the liver is producing glucose, the I/G is above 3. After a three-days fast (starvation), when gluconeogenesis is maximum, it declines below 1, whereas after a glucose infusion it rises to 16; following the ingestion of a carbohydrate meal a ratio as high as 70 may be observed. Therefore, the insulin-glucagon ratio of 'biologic equality', at which each hormone nullifies the action of the other and hepatic glucose balance is zero, must be somewhere between 3 and 70. Since the insulin-glucagon ratio necessary to achieve biologic equality is relatively high (above unity), glucagon seems to be far more potent than insulin on a molar basis. A small change in its concentration, therefore, would have a relatively large effect on glucose balance.

The influence of the potent gluconeogenic precursor alanine in the fasting state causes a fall in 1/G, a "catabolic response." The amino acid raises the I/G during a glucose infusion, an "anabolic response", so that it is spared from gluconeogenesis. A similar bihormonal relationship needed for glucose production has been observed after protein meal. These observations explain the well-known "protein sparing action" of glucose. They also explain why sick persons respond so poorly to intravenous adminitration of amino acids, unless glucose s also provided to raise the I/G from "catabolic" to an "anabolic" level. n addition, they partly form the basis or the isocaloric carbohydrate restricion, currently in vogue as a means of veight reduction; increased excretion of ketones and urea would be xpected as a result of a low I/G and ts failure to rise normally in response o a protein meal.

urrent view on diabetes mellitus

The traditional view of diabetes nellitus, and a view still held by most

Symptoms of diabetes

THOUGH diabetes may appear in persons of any age group, it is more prevalent in obese middle aged persons. In India it is estimated that for every known case of diabetes, there is one more which has not been diagnosed. Also, diabetes is more common among the urban people than in rural folks.

The diabetic suffers from excessive thirst and hunger, excessive urination, weakness, repeated boils and other skin infections, delayed healing of wounds. They also may have smooth tongue and swollen gums, numbress in hands and feet and cramps in legs. In severe cases, breath smells of acetone. It may also be associated with arterial diseases. In females, there is excessive irritation of vagina and even menstrual periods may cease. Urine test of diabetics shows a high amount of sugar.

In the advanced stage, it may lead to coma which may be due to two reasons: low sugar level in the blood due to overdoses of insulin and secondary factors such as excessive strain or low food intake. Patient becomes restless and feels palpitation and excessive cold sweating. This is called 'Hypoglyconic' coma.

In the second case which is known as diabetic comma blood sugar is very high accompained by the presence of ketones. It occurs most in patients who have not taken insulin treatment. He suffers from lack of appetite, nausea leading vomiting, drowsiness, pain in abdomen, dry skin and mouth with be breath, low blood pressure as weak but rapid pulse.

Diabetes may also lead to oth complications, such as defecti vision, neuritis, etc.

Recently a new test has been trifor early detection of diabetes mel
tus. It has been found out th
both insulin and glucagon, the ty
harmones from pancreas, bind wi
leucocytes of the blood. But on to
onset of diabetes, the harmones of
not bind completely with whi
blood cells (W.B.C.) or leucocyte
It is achieved by administering insul
and glucagon into the blood. Anal
sis of blood is carried out to see wh
ther the hormones have been bour
with W.B.C. or not.

It was found that nine out of to who had diabetes in their familishowed defective hormones binding with W.B.C.

If the test becomes complete successful diabetes can be prevented in persons who had it in their familie In such cases it can be corrected on by giving preventive diet.

N.1

laymen, is that the disease is a rather simple metabolic disturbance resulting from impaired insulin production alone. As clinical and research experience became more extensive, it was obvious that some factor in addition to impaired insulin secretion is operative in diabetes. This prompted interest in the involvement of glucagon in the human diabetes syndrome. The diabetic state has recently been categorised as a bihormonal disorder. In addition to a total or partial hyposecretion of insulin by the β—cell, there appears to

be an absolute or relative hyposup pressibility of the a—cell to glucose This bihormonal abnormality of the islets of Langerhans is expressed by inability to increase the insuling glucagon ratio in a normal manner to a reduced need for endogenous glucose production, i.e., following the ingestion of food. In other words the diabetic is less able to convert the fasting bihormonal pattern to the normal post-pandrial "anabolic" pattern and, in a sense, the ratio is frozen at or near the normal basa "catabolic" level. In the mild adult

ype diabetic who consumes a large arbohydrate meal, the I/G may rise rom 3, for example to 7 or 8, but will ot approach the normal maximum of 0. A juvenile-type diabetic, in whom insulin secretion is of course mpossible will exhibit no change in G in response to a carbohydrate neal. A protein meal which in a ondiabetic almost doubles the I/G atio will in the juvenile diabetic, ause a fall in the same ratio, a resonse not unlike that of a starving ondiabetic. After a beef meal such atients exhibit a rise in plasma lucose averaging more than 40mg/ 00 ml. This is interpreted to reflect he glycogenolytic-gluconeogenic efect of the lowered I/G. Furthernore, the unexplained deterioration f the diabetic state, often observed uring infection or trauma, could be consequence of hyperglucagonemia esulting from the elevated levels of lucagon-stimulating amino acids ntering the circulation from diseased reas where protein breakdown is ugmented.

The nonsuppressibility of the diaetic a—cell by hyperglycemia must hean that the total amount of gluagon secreted each day is greater han in nondiabetics. It is conceivble that the so-called "insulin resisance" of the diabetic patient is a onsequence, not of some unidentified asulin antagonist, but of a nonsupressible glucagon secreting a—cell. The presence of severe and absolute typerglucagonemia in patients with diabetic ketoacidosis may explain the enormous quantities of insulin frequently needed in the early phase of treatment of this metabolic syndrome. When, at last, under the impact of massive doses of insulin, glucagon returns to normal level, the critical first phase of ketoacidosis is over and the patient no longer is insulin-resistant. While other factors may contribute to the insulin resistance of diabetic ketoacidosis, the role of glucagon excess may be important.

Apart from the lack of suppression of a-cell by ingested or infused glucose, absolute basal hyperglucogonemia has been observed in some genetic diabetes. Therefore, it appears that, whether hyperglucagonemia is relative or absolute, the a—cell in diabetes is autonomous of glycemic control-a control which is rather dominant in nondiabetics. In view of this and of the fact that both α-and B-cells arise embryologically from a common source the possibility that the a-cell autonomy of diabeticsi s primary and inherited rather than secondary to the \(\beta\)-cell disorder, warrants serious consideration.

Conclusion

Glucagon and insulin, the two polypeptide hormones of diverse structure secreted respectively by the juxtaposed α—and β—cells of the islets of Langerhans in the pancreas, participate actively through their

opposite actions from fetal life unt death, in the moment-to-momen regulation of glucose, fatty acid an amino acid metabolism. Indeed it has been suggested that these twi hormones play a mediating role i nutrient balance, determining th "anabolic-catabolic" setting of th organism. Available evidenc supports the hypothesis that in dia betes mellitus both components of th n-β-cell couple function abnor mally with respect to fuel supply This is not surprising in view of th fact that despite the free availabilit of insulin, diabetes still constitute a major cause of death in the deve loped world. While insulin defic ency in diabetes should not be over looked, the efforts in correcting th associated glucagon excess migh provide an improvement of therapy

Further reading

- Unger, R.H., Glucagon physiolog and pathophysiology, New Eng J. Med., 285, 443, 1971.
- Unger, R.H., Glucagon and the insulin: glucagon ratio in diabete and other catabolic illness, Diabetes, 20, 834, 1971.
- Lefebvre, P.J. and Unger, R.H. Glucagon-molecular physiology clinical and therapeutic implications, Pergamon Press, Oxfor and New York, 1972.
- Unger, R.H., Alpha-and beta-ce inter-relationships in health an disease, Metabolism, 23, 581, 1974

FALLACY

he fallacy in the argument lies in ur assertion

X>Y + log X > log Y

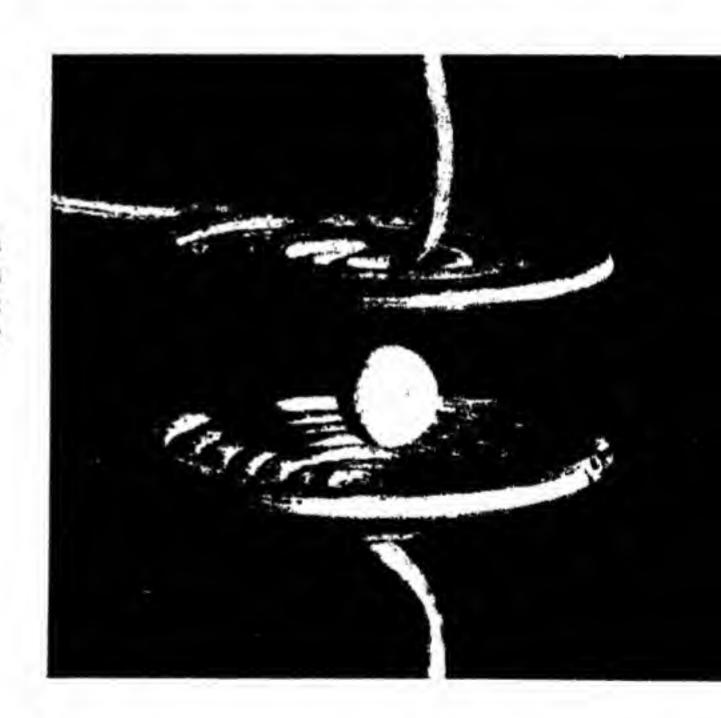
This holds true only when a>1
When a<1 (as in the foregoing proof)

X>Y- log X < log Y, i.e., the

sign of inequality changes who logarithms are taken to a base < So the error lies in the assertion 4>2→log, 4> log, 2.

MELTING BY LEVITATION

Levitation is no longer a mystery. Metallic masses can now be levitated in space in an induction coil for better casting



L subject of fiction at least for netallic materials. Many metals and lloys are now melted routinely in a tate of levitation for a wide range of aboratory experiments.

ast by accident when Mr. Cavor east expected it. He had fused ogether a number of metals and ertain other things and he intended to leave the mixture for a week and then allow it to cool slowly. Inless he had miscalculated, the last tage in the combination would occur

when the stuff sank to a temperature of 60° F...."

".... So soon as it reached a temperature of 60° F and the process of manufacture of cavorite was complete, the air above it, the portions of roof and ceiling and floor above it ceased to have weight...."

By H.G. Wells, in 'The First Men in the Moon'.

The idea of levitation has always fascinated the scientist and the layman alike. So much so that it has often been described as the ultimate test of miraculous powers. Many

saints became more venerable b cause they were said to be capab of levitation. In the realm of science however, levitation is no longer mystery. Although, nobody ha ever discovered Mr. Cavor's conco tion, cavorite, which would not on become 'weightless itself at 60 F' but would also make the su roundings weightless too. Levitation of small volumes of metallic materia is now routinely carried out in mar laboratories. Masses as large as quarter of a kg have been levitate using electromagnetic forces

or. Ray is Assistant Professor in the Dept. of Metallurgical Engineering, I.I.T. Kanpur; Shri Reddy works in the same department

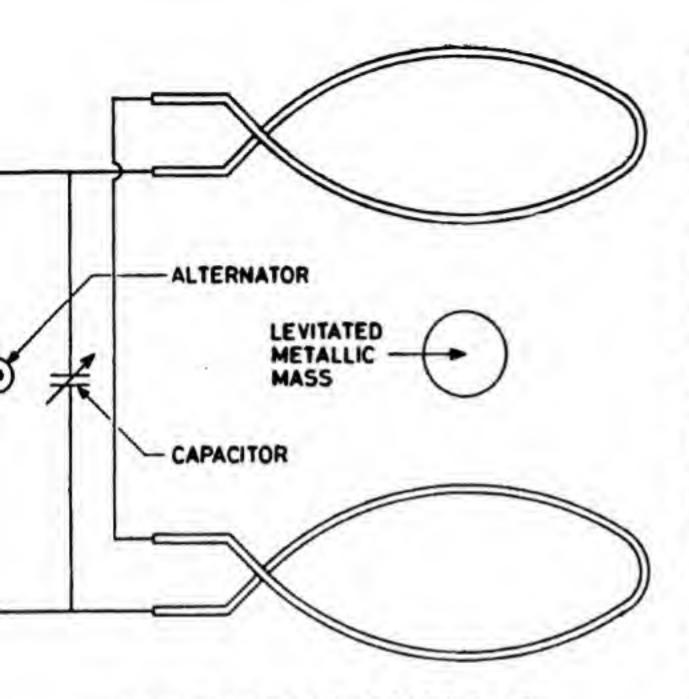
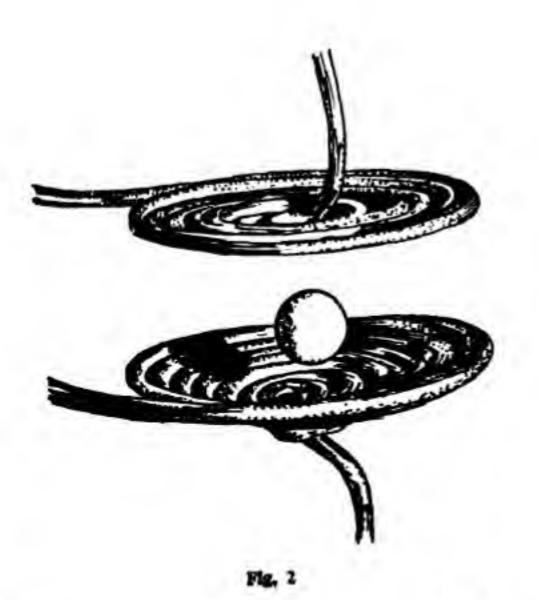


Fig. 1. Basic electrical circuit for levitation coil



coenteract gravitation. Levitation of electrically nonconducting particles may also be achieved if they are adequately mixed with electrical conductors.

It is easy to conceive an arrangement where magnetic fields are used to balance gravitational forces. It is also said that a short bar magnet will float in a superconducting lead bowl (at below 18 K). When the metal is superconducting at very low temperatures it loses electrical resistance and becomes diamagnetic. It no longer allows the magnetic lines of force to pass through the body. As the lines of force are repulsed, the magnet simply floats up (S.R., Jan. 1976, p. 59). Such arrangement, however, would be applicable to magnetic materials only.

In this article we describe a technique where metallic masses are levitated in space in an induction coil. First developed in Germany, in 1920, this technique is finding increasing applications in recent years in a wide range of metallurgical experiments. The technique is particularly attractive for reactive metals like titanium, zirconium, etc., which in the molten state react with all conceivable container materials. Such reactions introduce impurities which adversely affect the properties of the above metals.

The basic principle

The basic principle of levitation melting is simple. The solid metal is melted by induction heat, which is produced by the eddy currents induced in the solid. The induction coil is supplied with an alternating current of radio frequency from as low as 10 kc/sec. to as high as 400 kc/sec. The basic electrical circuit is shown in Fig. 1.

One needs a force to maintain the material at the axis and above the coil. This is achieved by using the two coaxial coils connected in series across a common capacitor so as to constitute a parallel tuned load

wound that the direction of the current (AC, 600—1200 A) in one, at my given instant, is in opposition to that in the other. The current in these fixed coils induces in the metal charged eddy currents which interact with the radio frequency field, around the coils, to give rise to lifting forces as well as lateral restoring forces. A photograph of a levitated aluminum sphere is shown in Fig. 2.

Stability of levitated mass

Any conductor placed in an electromagnetic field will move from the stronger to the weaker part of the field. For levitation the field strength must decrease vertically so that the body can find a position on lifting where forces are balanced. For

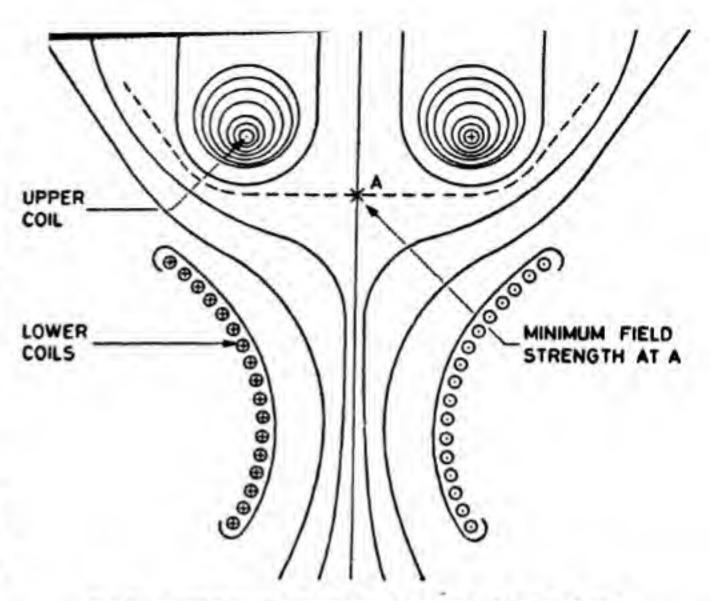


Fig. 3. Distribution of electromagnetic field with a levitation coil

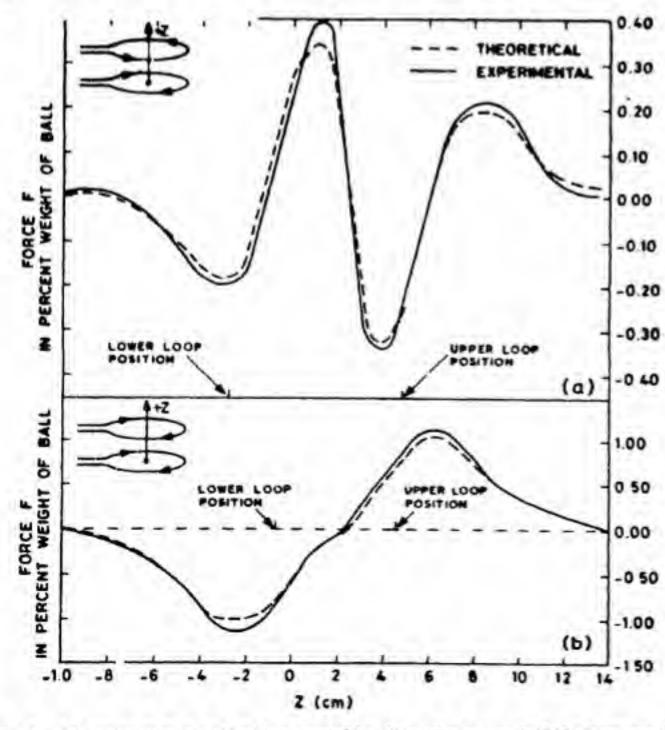


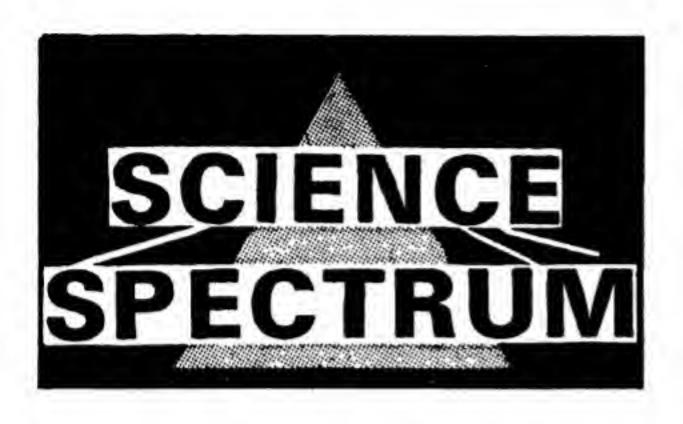
Fig. 4. Lifting force on a solid sphere exerted by alternating magnetic field of two coaxial circular loops with the current directions opposed (a) and unopposed (b), force is along the common axis. Material: 2.54 cm bronze ball loops: 0.635 cm copper tubing, 12.32 cm in diameter. Current:. 600 Amperes, 9600 cycles per second

lateral stability the field strength must decrease steadily towards the field axis so that it provides a restoring force towards the axis. Such a field is obtained by using an arrangement of coils shown in cross section in Fig. 3.

The various forces acting on a mass of metal under a given arrange ment may be calculated from theory Fig. 4 summarizes the main conclusions of such calculations. The figures also indicate experimentally determined values, which agree very well with computed data and show how the lifting force on a solid meta sphere varies due to alternating magnetic fields of two coaxial circular directions with current opposed, and in the same direction respectively. The force indicated is along the common axis.

Fig. 4a depicts a stable situation whereas Fig. 4b depicts an unstable one. In the former, if the sphere is placed at the axis midway between the loops and then displaced slightly along the axis either way, a force acts tending to restore it to the centre. In contrast, in the arrangement of Fig. 4b, the forces would tend to move the sphere farther from the

JULY 197



Past dynamism of earth

T took earth billions of years to mould itself from a ball of hot ases to the present multicoloured, nultifarious and multitudinous life and environment. Indeed, the prosesses that brought about the chances were slow, at times violent and systerious.

rigin and formation

A gaseous nebulae condensed to orm the solar system out of which arth was one (Origin of solar system R., Oct, 1975). Not only matter conensed at a spot but also accreted, e., the matter from the surrounding pace was swept in to form the earth. s the matter went on piling on its urface, gravitationally the earth ecame stronger to grab more matter; s a result it started getting hotter iside. The heat produced due meteorite bombardment, and adioactive decay of uranium, horium, potassium that it contained, aused the interior of the earth to nelt. It led ultimately to the rehuffling of the materials. This nevitable development is called on catastrophe.

Molten iron and other heavier naterials percolated down to the entre of the earth to form what is nown as core, which is still molten.

The lighter material percolated to the top to form slag, that today forms the crust and upper mantle (the middle portion) of the earth. A phenomenon similar to the fractional crystallization of gases then took place. The lighter igneous material, e.g., aluminium, silicon, alkali metals, which form the granite rock floated to the surface, while the basalt and gabbro rocks, which contain calcium, magnesium and iron-rich silicates, settled down to form the lower part of the crust and upper layers of the mantle. The only anomaly that is seen in the chemical distribution of materials in earth is the presence of heavy materials like uranium and thorium on the surface. They should have been deep inside. This is not so because their structures do not fit in with the densely packed structures of the chemical compounds present in the core. As a result, these materials were almost "squeezed out" from the core to fit into the widely spaced structures of the compounds lying at the upper layers of the earth.

When did the "differentiation" take place? Geologists are undecided about this. Some claim that it occurred immediately after the earth was formed while others think it happ-

ened a billion years afterwards. It is certain that the differentiation caused many other beneficial changes that favoured man's existence of what may have otherwise been dry, lifeless planet.

The other change the shuffling of materials brought about was th evolution of various gases, e.g carbon dioxide, methane, water gases containing sulphur, etc. Dur ing the formation of earth, thes gases were locked in at variou depths. While shuffling they burs forth through the surface in hug amounts. The effects the gases pro duced on the earth while ejectin out of the surface was analogou to that produced when water vapour bubble out of rice porridge, makin the surface around the bubbles rise So the face of the earth wore wrink les. Plate tectonics, mountain for mations and volcanic activities the began on the earth.

At this stage of the evolutio the surface temperature of eart was low enough to condens water. Had the temperature bee high, the gases would have formed gaseous envelope around it, t allow the greenhouse effect to tak place. Earth then would not hav been what it is today. It would have been like Venus -having a hot sur face and atmosphere, incapable of evolving higher forms of life. Be sides the temperature being help ful, earth's gravitational pull was als as strong then as it is today. It was able to hold to itself all gases excer the lighter ones like hydrogen an helium.

As the water condensed, it rained down on the earth. Calcium and magnesium of the rocks were eroded by rains to mix with gases to forevarious compounds. There was continuous heavy downpour all over the globe. This in conjunction with wind put the things on the surface of earth in right order. They acted like a broom to clean the surface of debris, carrying it down to the bed of the oceans that were then forming the rivers that we see today are the

vestiges of those prehistoric modes of transportation.

Evolution of life

The precise date when life appeared on earth is difficult to imagine. We have to rely on what the fossils tell. Although organic carbon, the basis of life, has been found in many of the oldest fossils, its presence cannot always be attributed to the presence of life. It might be a product of non-living chemicals. The oldest fossil is that of fig tree chert found in Swaziland, Africa, dated 3.4 billion years. Evidence of algal life has been found to be about 2 billion years old.

The environment of earth when life evolved was something like this: The atmosphere contained mostly water, methane, ammonia and carbon dioxide. It was midway between that of Jupiter which can even hold hydrogen and that of moon which cannot hold anything. As ozone was then not present in the upper strata of the atmosphere as it is today, ultraviolet radiation from the sun scorched the surface of earth. It helped in the synthesis of a variety of organic compounds, e.g., amino acids. The next steps that led to the formation of nucleic acid and the "making" of life is not yet clear. They are as unclear as the range of environments that were then present to help the processes, except that water was certainly available.

As life evolved on earth, first in cellular forms, then in differentiated forms, and later as higher organisms, it bore its effects on the surface and on the atmosphere of the earth. The evolution of life even helped in accelerating the evolutionary process! A good example is that of oxygen. As free oxygen in the atmosphere increased due to the photosynthetic activity of blue-green algae, it accelerated the evolution of higher organisms, in particular metazoans. These organisms, which need a small

quantity of oxygen for metabolic processes, have cells with differentiated characteristics. Even methane gas must have evolved then, it is felt, as it is a byproduct of a bacteria that produces marsh gas over swamps.

All this happened in Proterozoic era (2 billion-500 million years ago) when bacteria, algae and other primitive single cell-organisms were present on the land and in seas. At the end of that era, earth-moon system had became stable. The only difference between then and now is that tides those days were higher.

The formation of animal shell in the metazoans, which is meant for protection and for holding muscles, has its own significance and bearing upon the evolution of the planet, its inhabitants and exterior dynamics. The shell-bearing animals populated the oceans, whereby the beds became filled up with calcium carbonate, calcium phosphate and silica, which eventually formed sediments of limestone chert and phosphate rock. The last one served as a good fertilizer for plants.

Hereafter, by the end of Proterozoic era, events took a dramatic turn that finally led to the present diversities on the earth. While the earth was populated by single-cell forms for almost 3 to 4 billion years, the metazoans became ramified into various invertebrate organisms within a few million years and formed the major phylas. The vertebrates and vascular plants also became established and ramified themselves during the same period. How such a fast diversification in living beings took place is not understood. The best guess for this biological evolution is that oxygen, which then rose to the present level in the atmosphere, helped it. By the coming up of Mesozoic era, i.e., 225 million years ago, all kinds of flowers, fauna and grasses had bedecked the earth.

Continental drift, climate and mag netism

The past glacial remnants and mag netic fields have enabled scientist to confirm that continental drift die take place.

The earth has been cooling for th last 50 million years. During thi period it had many times undergon glaciations known as Pleistocene ic ages. Glaciations take place parti cularly when a continent is at th pole. The heat transfer, because of the presence of continent, somehow gets disturbed and so heat is no evenly distributed -the glacials ad vance. It is however not understood why the temperature of the surface of the earth drops so low as to produc glacials but not a complete freeze over, as at the equator the ocean remain as they are. The glacials i the remote past have covered Nort Europe, Asia and North America They also affected the homo sepian that had evolved by then to get dis placed as the glacials advanced an retreated. It is about 100,000 year ago that the glacials have retreate to their present positions. This retreat, it is claimed, is a temporar one.

When a rock containing magneti substances is heated and then cooled the magnetic lines of force get fro zen inside it along the direction of the earth's magnetism. So any roc bearing the traces of magnetism will tell the direction of the magne tism of earth when it was frozen in On this basis, it has been found that the magnetic poles of the earth hav drifted with the passage of time This, in actuality, however, has no happened. In fact, it is the drifting of the surface features of the eart that has caused it. The phenome non of "the reversal of magneti poles" that took place between th Proterozoic era and now is attr buted to the instabilities in the flui motion of the core. It is now believe the core creates earth's magnetism.

It is obvious that the earth has never taken respite ever since it came into being, and it never will. It is

equilibrium—always exchanging energy from its inside, to the surface.

to the seas, and to its atmosphere, and conversely from the sun to its surface and inside. Raymond Siever put all this aptly in Scientific American (Sept. 75) —"On the earth stillness is remarkable for its rarity."

DILIP M. SALWI

Radio astronomy

D ADIO astronomy is the study of the universe by means of radio waves. Along with the isible spectrum from the stars comes range of signals which are received over the radio frequency spectrum. some of these signals come from eighbouring objects like the sun nd the planets, others from vast osmic eruptions in the depths of pace. A study of these radio waves ives a new look at the universe, eveals unexpected activity in the uter layer of atmosphere of the sun nd furnish the first idea of the hape of the galaxy of which the sun orms a minute part. The informaion which is collected in this way loes not supplant but supplement and s complementary to what is learnt y optical astronomy.

The basic method of observation s to take a sensitive aerial system, sually a parabolic reflector with a mall pickup aerial at the focal oint. This is connected to a highly ensitive receiver and the output is ecorded on a pen recorder. If n object emitting radio waves passes brough the beam of the antenna, an ncrease in signal is observed. The width of the signal gives information n the size of the source and the way which the signal varies over the adio frequency range suggests the node of origin of the signal and ecide whether the signal is generated s plasma type oscillations or synchotron type radiations.

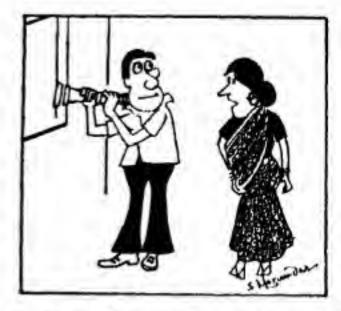
Large optical telescopes produce etailed pictures of distant celestial

objects while in radio telescopes the shape and sizes of all objects smaller than the sun or moon are completely lost in the blur produced by the radio waves. On the other hand, things that are not seen by optical telescopes can be revealed by radio waves. The main difficulty, however, is to see a reasonable amount of details in the sky with radio observations. The amount of details that can be seen by an optical instrument such as a telescope is determined not by the carefulness of the design but by the wave nature of light. The larger the aperture of the telescope, the smaller is the blur produced and hence greater details can be seen in the sky. In the sky few distant stars can be seen like points. The energy from each star is emitted as waves in space and part of this arrives at the earth in a procession of plane wave fronts. In a plane wave the electric or magnetic field of the radiation from the star, in any plane normal to the direction of the star, has the same measurement at any point on the plane. Optical telescopes are capable of collecting energy from nearby stars and simultaneously recording it on photographic plate. The radio telescopes, because of their small aperture, can not do this and in fact can record only one region at a time. Hence in addition to low resolving power, they are deficient in gathering information compared with optical telescopes.

It is, therefore, necessary to devise new types of radio telescopes that are

not the analogous of optical telesscopes. The first development in this line is the use of two beam interferometers. If a source of emission in the sky is scanned by a slit then a curve is obtained which shows the one dimensional brightness across the source as a function of scanning angles. This brightness curve, like all continuous functions, are in turn represented by a Fourier series of brightness harmonics. These brightness harmonies are determined by observing the source with two antenna interferometer, the different harmonics being determined by changing the length of the baseline of the interferometer. The interferometer does not have the sensitivity of the large paraboloids, but it has high resolving power on discrete sources. The resolving power being a function of the base line distance and by making this several thousands of feet, the angular diameter of radio sources may be measured down to seconds of an arc.

The two dimensional brightness distribution over the source can be found by determining the brightness harmonics over a complete angular range of scanning angles followed by the Fourier transformation of the field. This method has the advantage of making the aperture of the telescope large, resulting in high



"You could locate Saturn rings, but you have not yet found my ring that I dropped in the kitchen." esolving power. This process is ecoomical one as two small antennas orm the minimum requirements and rovide image of a whole region of ky and not one point at a time. The ain disadvantage of this telescope is nat it takes many nights of observaon to complete the synthesis of the lescope aperture. Another imporint development is the use of earth's otation to synthesize a two-dimensonal antenna from a linear one. buring the day celestial bodies appear rotate in angle with respect to the orth's horizon. Hence the telescope not shifted but the response of the elescope is adjusted to follow a gion in the sky for several hours. ambridge earth rotational synthesis strument named 'Supersynthesis' is ne such example.

The output of any source is ifferent in wave shape from that of ny other source, i.e., it has its own Reflector radio telescope ode. akes use of the coding of the signals ut it adds to it any other signals ke receiver noise that arise from ources with different coding. In a orrelation telescope signals are ollected from two different parts f a wave front and only the signals hich have the same coding are ccepted. In the cross telescope the ollecting system consists of two arrow strips at right angles to each ther. One collects energy from a rip of sky in one direction, the other om a strip at right angles. The nly place in which the same source ill be seen by both halves of the elescope is in the interaction of the wo strips. Hence the response of ne cross is only in this small central egion where each part of the antenna eceives the same coded signal. hus the cross with relatively small rea has the resolving power of a arge aperture. In this way a fixed eam is obtained pointing in a given irection in the sky, and is an extrenely useful device for survey purposes and for detecting the position of extra-galactic sources. A different type of antenna is also built with a combination of a cross and the grating type telescope. The latest of the telescopes designed is the ring antenna, known as radio heliograph, which comprises of a ring of paraboloids along a circumference. By an ingenious device the ring of antenna is made to have the angular response of a huge aperture of the classical telescope type.

The receivers used in radio astronomy are of conventional design but are built to be of highest possible sensitivity to integrate the signals over an appreciable fraction of time. However, recently masers and parametric amplifiers have been built having an improvement in sensitivity over the old receivers and thus increasing the potential of radio telescope systems.

Most of the recording of radio astronomy signals is done with conventional pen recorders. However, with giant telescopes the rate at which information is collected is so great that analysis and reduction of the data present a formidable problem. The output from these instruments will therefore be in digital form, and the analysis of the data is to be carried out automatically by electronic computers.

The exciting investigations carried out in radio astronomy is survey of the radio sources in the most distant reaches of the universe. The results from this unexplored region are used to decide between the two outstanding theories of origin of the universe namely the 'big bang' theory

of Lemaitre and the 'steady stat theory of Hoyle. According t the first theory the whole of th material in the universe was one concentrated in a small volum which later exploded and has since then been expanding at an increasing rate. Hoyle's theory postulates that matter is continuously being create throughout the universe. Another investigation which contributes t the knowledge of the solar syster is the direct exploration of th planets by space vehicles. Th power radiated from these vehicles exceedingly small and only th largest telescope is capable of rece ving them, and giving the first direct information about conditions of the surface of these planets. Marti Ryle of the Cavendish laboratory Oxford, using the technique of aper ture synthesis finds that the number of radio sources appear to decreas with distance from the earth Their observations supported th 'big bang' theory of Lemaitr in contrast to the 'steady state theory of Hoyle. While studyin rapid vibrations of distar signals with radio telescope havin an array of dipoles capable of shorte exposure, Anthony Hewish, also of Cavendish laboratory, noticed that objects in certain parts of the sky ar sending out regular pulses of radi waves at an interval of one half t These are know two seconds. as pulsars and Hewish interprete them as signals coming from sma celestial bodies that are spinning DR. S.K. KUND

Prof. of Physic Reg. College of Education, Mysor

On the time of vernal equinox

THE other day, an Iranian national residing in Hyderabad phoned me to find out the exact time of Vernal Equinox in 1976. It

is a pre-Islamic Aryan custom in Iran to celebrate their Nav Roz a that particular moment of time. informed him that, according to the iculated ephemeris, the Vernal quinox (V.E.) in 1976 falls on the Oth March at 17:20 Indian Standard ime (I.S.T.), i.e., 11:50 Greenwich Sean Time (G.M.T.). On hearing is he was somewhat surprised, ecause the V.E. is traditionally apposed to fall on the 21st of March. Vhen I explained that the date had hifted back by one day because 1976 appens to be a leap year, which has 9 days in the month of February, he as satisfied. Actually my explaation was only partly ecause the time of the V.E. varies rom year to year in a more compliated manner. The purpose of this rticle is to describe this variation nd explain how the Gregorian alendar has kept it in eighbourhood of March 21.

The variation in the G.M.T. of E. arises from the fact that the me required for the sun to move rom one V.E. to the next is roughly 65 days, 5 hours, 48 minutes, 45.8 econds. It is the length of what is nown as the tropical (Fasti) year, e., the year of the seasons. Consequently the times of V.E. for the next ew years would be:

977-March 20, 17:39m GMT 978-March 20, 23 : 28 GMT 979-March 21, 05 : 16 GMT hey are shown by open circles in he upper part of the Fig. I. It may be pointed out here that the bove times are likely to be off by few minutes (less than 12) either vay, because we have not taken nto account the minor variations aused by the effects of nutation and danetary precession. We continue to neglect them in further liscussion as we are more concerned with the mean values.

Continuing in the above manner the time of V.E. in 1980 would be March 21, 11:05 GMT, as indicated by the end point of the dashed line in the figure. However, 1980 being leap year of 366 days including

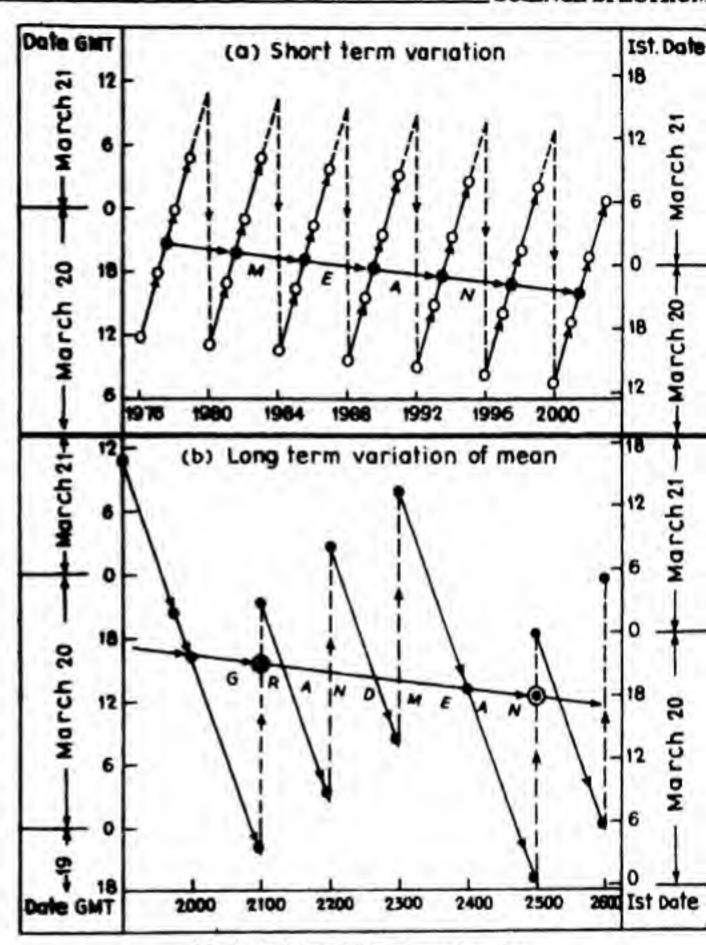


Fig. 1. Variation in time of vernal equipox

February 29, the V.E. will fall on March 20 at 11:05 GMT in 1980. Thus the leap year brings the V.E. backward by one day as indicated by the dashed arrow in the figure. The step-wise variation of V.E. from 1976 to 2003 is depicted in the upper part of the figure.

If we now take the means of V.E. times for each four-year period 1976-79, 1980-83, etc., we obtain the filled circles in the upper part of the figure, which show that the mean is fairly constant around March 20, 18:18 GMT at present. The introduction of leap years serves to keep

the V.E. time fixed to a certain extent. But from the figure it is also obvious that the mean is slowly slip ping backward from March 20 20:33 GMT in 1976-79 to March 20 16:48 GMT in 2000-2003, or, appro ximately by 45 minutes in four years This is so because the four civil years including one leap year, are equal to 1461 days while the four tropical year rs are equal to 1460 days, 23 hours 15 minutes, 03.2 seconds. It was only to offset this slow backwar slippage of V.E. away from March 2 that Pope Gregory introduced h calendar reform.

In the Gregorian calendar only hose centuries, the figures of which ire divisible by 4, are taken as leap ears, e.g., 1600, 2000, etc., while the other centuries with their figures not livisible by 4, such as 1900, 2100, etc., are not taken as leap years. The effect of this reform on the mean time of V.E. is shown in the lower part of the figure. Here the march of the 4-year means over centuries is ndicated by the continuous arrows. It takes into account the effect of the eap years. In the 1900-1903 period this mean was at March 21, 10:47 GMT, and since the cycle of leap rears is not broken for two centuries ipto 2100 A.D. the mean continues o drop reaching as low a value as March 19, 22:04 GMT for 2096-2097. f we had continued in the same way he mean would have become March 19, 21:19 GMT for 2100-2103. But ince 2100 is not taken as a leap year we get a jump of one day bringing the nean to March 20, 21:19 GMT for hat period as indicated by the vertial dashed line. After this adjustnent the backward movement of the nean time of V.E. will continue for ne century until the same step-jump of one day would occur in 2200 A.D., nd a repetition of this adjustment in 300 would finally bring the mean ime of V.E. to March 21, 07:51 GMT for the period 2300-2303 as hown in the figure. The step-wise ariation of the mean time of V.E. would follow the same pattern in ach successive 400 years period 300-2700, 2700-3100, etc.

Let us now take the grand mean for he 400 years periods. In the case f the period 1900-2300 it is found to e March 20, 15:32 GMT centred at 100 A.D. and for the period 2300-700 it is at March 20, 12:37 GMT entred at 2500 A.D. These grand neans are shown by large circles with entral dots in the figure. It is seen hat even in the Gregorian calendar he grand mean is slipping back by 2

hours and 55 minutes in each 400 year period. Consequently we will have to introduce another correction for bringing the grand mean of V.E. time back to March 21 ± 1 day.

Backward calculation shows that the grand mean time of V.E. was at March 21, 12:00 GMT around 700 B.C. Similarly the forward extrapolation would make it March 20, 12:00 GMT around 2600 A.D., i.e., a shift of one day in 3300 years. After 2600 A.D. the grand mean time of V.E. would be more than 12 hours behind March 21, 00:00 GMT. This can be avoided by dropping the year 2800 A.D. from the list of leap years although it represents a century with its figure divisible by four. A similar correction will have to be applied again in 6000 A.D., 9200 A.D., etc. For the past, the years 400 B.C.,3600 B.C.,etc., would not be leap years. The formula could be written as: If for any century the number (century figure +4) is divisible by 32, it will not be a leap year. However, it may be pointed out that even after applying this correction the overall mean time of V.E. would still continue to move back by about 44 minutes in 3200 years, necessitating a further correction, but only after

a long period of about 100,000 years

We have now seen how the Grego rian Calendar and the above extr correction keep the grand mean tin of V.E. between March 20, 12:0 GMT and March 21, 12:00 GM7 But if we consider the actual varie tion of V.E. time we should tal into account that: (i) the 4-year mea can differ from the grand mean b ±18 hours and (ii) the yearly valu can differ from the 4-year mean b ±9 hours. Hence the actual tim of V.E. in a given year would diffe from the grand mean by as much a ±27 hours during the whole cycl of 3200 years. It may be foun anywhere between March 22, 15:0 GMT and March 20, 09:00 GMT a the beginning of the 3200 year cycl and anywhere between March 21 15:00 GMT and March 19, 09:0 GMT at the end of the cycle. Durin the 400 years from 1900 to 2300 th V.E. time would lie between Marc 21, 19:00 GMT and March 19 13:00 GMT, hence we should not b surprised if in a given year durin that period it occurs on 19th, 20th o 21st March.

> K.D. ABHYANKA Astronomy Depti Osmania Univ., Hyderaba

Anomalous natural reactors at Oklo

I named after a uranium ore considerable interest to geologists, isotope-geochemists and physicists. It has been found that nuclear reactions took place there within the uranium-rich ore for a period of at least 100000 years, some 1800 millions years ago.

It is a familiar fact that, of the two principal isotopes of uranium which are radioactive in nature, uranium-235 has a shorter half-life than uranium-

THE Oklo phenomenon, which is 238 (7.1 × 10° years against 4.51 × 10° years). Consequently, the concen mine in Gabon in West Africa, is of tration of uranium-235 in natura uranium steadily decreased with th passage of time. In the remote pas it was much higher than it is nov (3.65% two thousand million year ago against 0.72% now). A routin analysis of uranium at the Peirrelatt Laboratory in France showed a sligh isotopic anomaly in the ore—the con centration of fissionable nuclei wa found much below the normal Uranium-235 has a concentration of s little as 0.29% as compared with ne 0.72% found in natural uranium f normal isotopic composition. tut by the time this came to notice, arge quantities of the ore had been applied to the nuclear industry.

The fission products found in the re clearly pointed out the origin of the anomaly. In the remote past, ssion chain reactions were triggered off spontaneously within the uranium eposit, and so parts of the deposit are behaved like a modern nuclear eactor for hundreds of thousands of ears.

The total mass of the ore, where the eaction took place, comes to more han 500 tonnes of uranium. The uantity of energy it must have eleased comes close to 100 × 10° Wh. The integrated neutron flux t some points exceeded 1.5 × 10° eutrons/cm³.

The nuclear reaction mechanism which allowed attainment of such igh rates must have been quite xceptional. The state of preservaion of the fossilized nuclear reacors' is, however, another of its emarkable aspect. The uranium has etained its configuration from the ime of the reactions so faithfully hat it indicates an exceptional conunction of various circumstances, .g., the local high concentration of ranium, an "enrichment" to over %, the absence of strongly neutron bsorbing materials and the presence f water as a moderator. These our circumstances, it is claimed, ave a finite probability to trigger off he fission chain reactions spontaneusly within the uranium deposits in he remote past. Even if such phenonenon had occurred and even if in ome cases there had been mechanisms which permitted the reactions to continue until the isotopic composiion of the uranium had changed ignificantly, most uranium deposits would have been considerably modiled over the ages with the presence of water. One assumption which appears to be best supported is that the reactivity was regulated both through the presence of neutron absorbing materials which were used up (the same method is employed in our present power reactors) and through variations of the amount of water in the uranium ore with the power development in the reaction.

In the Oklo geochemical environment, during the past 1800 million years, the fission product elements which migrated significantly were Kr, Xe, Cs, Sr, Ba, Mo and I. The migration of nuclides at Oklo is a problem of geological storage of radioactive waste. Two of the mobile elements, Sr and Cs, are important from a nuclear wastestorage point of view as they cause

damage to living organism. It has been found that the mobility of Sr was not sufficiently great as to result in its total displacement. It is possible that the rate of disposal was sufficiently low with respect to the half-life of "Sr (29 years), that little or no radioactive strontium escaped to the reactor zone.

A part of the deposit that yields anomalous uranium has been reserved for further scientific research. The numerous 'tracers' emanating from the nuclear reactions will be of much use in the study of geological history of the episode.

K. VENKATA RAMANIAH Laboratories for Nuclear Research Andhra University Waltain

Some proteins are sweet

T ITTLE is known of the molecu-Lar basis of either taste qualities or intensity of various taste stimuli. The recent application of artificial sweetening agents to new diet foods has revealed that there are several limiting qualities to the presently available sweetners (saccharin, cyclamates, aspartame, etc.). Several research approaches were used to sweetner. One find a superior screening approach used was tropical plant materials for intense sweetness.

Sweet compounds exhibit a wide variety of structures and until recently it was not known that a protein could also have a sweet taste. Proteins are polymers of amino acids. All amino acids except glycine are optically active because of the asymmetry of the a-carbon atom, which is covalently bonded to four different groups. The four different groups attached

to an asymmetric carbon atom car be arranged in two possible spatia configurations (arrangements) which are mirror images (enantiomorphs of one another. They are designa ted as D (dextro) and L(levo) isomer (Fig. 1). Naturally occurring amine acids always have the L confi guration, corresponding to the confi guration of L-glyceraldehyde. With the exception of L-alanine, severa D enantiomorphs of a-amino acid are known to be sweet compared to their corresponding L enantiomorph which are usually described as taste less or bitter.

An early tropical fruit protein isolated from berries of Richardell dulifica (Synsepalum dulcificum) has remarkable taste-modifying properties. These berries, called "Miracle berry", though tasteless have the intriguing property of making sour foods taste sweet after the fruit

Fig. 1

pulp has been chewed. This effect lasts for 1-2 hours. Dr. Lloyd Beidler of Florida State University (U.S.A.) showed miraculin, the active component, to be a glycoprotein (mol. wt. 44,000) in which the sugar moieties (L-arabinose and D-xylose) accounted for 6.7% of the protein. Nerve endings which are affected by (i.e., are receptive to) taste stimuli are known as taste receptors. Beider and his colleagues suggested that miraculin binds itself to the cell membrane at a site near the taste receptors. An acid initiates a change in the orientation of the receptor in such a way that the carbohydrate portion of miraculin stimulates the sweetness receptors.

Two other taste-active proteins known upto date are intensely sweet. One of them comes from the tropical plant Dioscoreophyllum cumminsii (Serendipity Berry). The protein s called monellin after the Monell Chemical Senses Centre, Pennsylvania, U.S.A., where it was isolated and characterised. It consists of single polypeptide chain of approximately 91 amino acids. It has mol. wt. of 10,700 daltons and is ome 3000 times sweeter than sucrose on weight basis. The second protein, thaumatin, isolated from Thaumatococcus daniellii, is also a ingle polypeptide chain. It is wice as long as the monellin moleule and tastes 750-1600 times as weet as sucrose.

All the three proteins—miraculin, nonellin and thaumatin—lose their aste-active properties on heating. This suggests that their three-dimensional structure is important for mparting sweet properties. The

amino acid composition of the proteins also shows some possible significant similarities.

The discovery that taste-active molecules from three tropical berries are proteins has far reaching implications on the nature of the hypothetical "taste receptors" with which the sweet tasting molecules are believed to interact. It is now known that several hormones affect their target cells by binding with specific receptors on the cell membrane. These hormones do not penetrate

the membrane and enter the ce but simply bind to the extern surface. It has been suggested the taste may also be mediated in the same way, i.e., the taste-active mol cules bind to the specific taste recen tors on the surface of the taste-bu cells of the tongue. Moreover, th taste-active proteins are large mole cules which are not able to ente tongue cells instantaneously. A one can appreciate a sweet tast within a short time, the existence of these proteins supports the abov hypothesis that the cell surface i all important in taste reception.

> PARVEEN K. LUTHRA Department of Biochemistr; Panjab University Chandigarh-16001-

Enriching food with amino acids

Amino acids occur mainly as protein constituents but they are also present to some extent in the free state in food. They are important factors in evaluating nutritive value and taste of foods. The nutritive value of a food depends not only on its calorific value but also on the quantity and type of amino acids it contains.

The total protein consumption in the world is about 112 million tons (34 million tons as animal protein and 78 million tons as vegetable protein Table 1). Meat and eggs are the ultimate products of vegetable protein. It may be said that the key to the problem of food protein in the world is the rational use of vegetable protein, i.e., rice, wheat, corn and soybean. This depends on how efficiently they are produced and utilized.

Essential matricuts

Amino acid fortification is the bes way to utilize vegetable protein efficiently and to increase production of animal protein. Protein from oi seeds, i.e., soybean, is most important as a source for animal feed. The limiting amino acid in soybean meal is methionine. The addition of lysine and threonine to cotton seed meal lysine to sesame meal, and lysine, threonine and methionine to peanut meal is recommended. Amino acid fortification has been practised in the manufacture of formula feeds for domestic animals and poultry, effectively converting vegetable protein into animal protein.

Fortification of food cereals with amino acids is obviously more effective from the point of view of direct utilization of food resources than the fortification of formula feed for

Table 1. World supply of protein

opulation (in billions)	4.0
nimal protein (in million tons)	33.6
Meat	16.1
Fish	4.0
Eags	2.2
Milk products	11.3
egetable protein (million tons)	78.0
Corcals	43.6
Beans	24.9
Fruits and vegetables	5.2
Root vegetables	4.3
Total (million tons)	111.6
Proportion of animal protein (%)	30

organisation (FAO) of the United Nations or the year 1975.

ne production of animal protein.

Iowever, amino acid fortification of
uman food requires careful study
relation to eating habits, cost
and social acceptability.

The fortification of wheat flour roducts is easy because powdered -lysine monohydrochloride can be ixed with the flour during its distriution. It was developed in Japan or the first time in 1962. As far as ne fortification of rice is concerned. mino acid required should be proared in the form of rice-like granus and mixed with polished rice to void any problems with the tradional manner of consumption. The ddition of 0.2% lysine monoydrochloride and 0.1% threonine rice is desirable from nutritional oint of view. Amino acid subantiated rice has been developed in pan, Thailand and the U.S.A. ysine-fortified bread is in vogue nd its nutritional value has been camined in India, Peru and Tunisia Table 2).

Taste of amino acids. The taste f vegetable food is mainly due to lutamic acid, other amino acids, rganic acids and sugars. The main ste substances in meat and meat roducts are glutamic acid and inonic acid. Other constituents, e.g., rganic acids, peptides, etc., may

and exhibits refreshing sweetness. Amino acids of low molecular weights, e.g., L-alanine, L-serine, and L-proline are generally sweet. On the other hand, L-leucine, L-phenylalanine, L-tyrosine and L-tryptophan are bitter. The bitterness of L-tryptophan is about half that of caffeine and the sweetness of D-tryptophan is 35 times as strong as that of sucrose. Although L-aspartic acid and L-glutamic acid are scidic, in neutralized solution they are tasty.

Free amino acids. Dark-fleshed fish contain high levels of free histidine. Fish with white flesh contain less histidine and much more glycine and alanine. Clams and snails contain large quantities of free amino acids, e.g., glycine and proline. Methionine is considered to be responsible to give specific taste of sea urchins. The amount of free amino acid is, however, not much in animal meat. Glutamic acid, alanine and histidine are present comparatively in high levels. Cheese contains amino acids available from the hydrolysis of milk protein. The

peculiar taste of cheese results from glutamic acid as well as valin leucine and methionine.

Asparagin, glutamic acid, glutamine and serine are found abundant in vegetables and fruits. The content of citrulline is high in melon Green tea is rich in glutamic acid aspartic acid and arginine. The peculiar taste of green tea is due to teanine (L-glutamyl- y - ethylamide as well as glutamic acid. Soybea sauce contains almost all amino acid including 20% glutamic acid.

As flavouring agents. The utiliza tion of amino acids as food flavourin substances has been considerable extended. Mono - sodium L-gluta mate is extensively used in the manu facture of various foods, e.g., fis paste products, instant noodles, fis sausages, meat products, soup stock special fish delicacies, seasoned fish products and curry paste. Sodium inosinate or guanylate when mixed with the products improves flavour Glycine is refreshingly sweet, and i used as sweetening agent in food manufacture. It is widely used in the manufacture of soft drinks, sour stocks, pickles, fish paste products

Table 2. Fortification of cereals with amino acids

Cereal		Protein efficiency ratio*	
	Amino acid added	Without amino acid addition	With amino acid addition
Rice	L-Lysine monohydrochloride 0.2%; DL-methionine 0.2%	1.50	2,61
Wheat	L-lysine monohydrochloride 0.2%	0.65	1.56
	L-lysine monohydrochloride 0.4%: DL-threonine 0.3%		2.67
Corn	L-lysine monohydrochloride 0.4%	0.85	1.08
	L-lysine monohydrochloride 0.4%; D-tryptophan 0.01%		2.55
Sorghum	L-lysine monohydrochloride, 0.2%	0.69	1.77
Barley	L-lysine monohydrochloride 0.2; DL-threonine 0.2%	1,66	2.26

Protein efficiency ratio is the ratio of weight gain to the total feed protein administered during the experimental period.

CIENCE SPECTRUM.

easoned fish products and fish lelicacies.

special applications

Odours resulting from the heat processing of food are due to degradative products of amino acids and tugars. Amino acids react easily with sugars even at a comparatively ow temperature, yielding not only rolatile compounds which are the major constituents of cooked food, out also substances responsible for the colouration of baked food.

In Japan, cysteine is permitted to be added to natural fruit juices as an intioxidant, or to bread as dough improver. Cysteine is also effective as an antibrowning agent. When natural fruit juice is stored, ascorbic acid is oxidized and eventually browning and reduction of the nutritive value occur. This can be prevented by addition of cysteine hydrochloride. The reductive power of cysteine can also be used to improve the paking process and bread quality.

Cereals like rice, wheat and millets, ragi, cholam and bajra form the main food in India. They contain 5%-12% protein, but these proteins

are usually deficient in the essential amino acid, lysine. Rice is deficient in threonine but richer than other cereals in lysine.

Pulses and legumes are rich in proteins. Pulse proteins, however, are relatively low in biological value because of deficiency of the essential amino acid, methionine.

Maize is limited in both lysine and tryptophan. Considerable work has been done on amino acid fortification, especially lysine enrichment of cereal and pulse-based diets at the Central Food Technological Research Institute, Mysore, and at other research institutes. Also, work has been done on the fortification of vegetarian diets with methionine and threonine.

The nutritive value of maize has been shown to increase by the addition of both lysine and tryptophan. Methionine has been shown to increase the nutritive value of soya products. The addition of methionine to groundnut flour also increases its biological value.

D.V. SINGH Central Research Laboratory Antibiotics Plant, Virbhadra Dehra Dun use of mulches or by other mean there is a recent approach to reduce transpiration by use of some chemicals, known as antitranspirant Waggoner (1966) reported the if transpiration is represented a

$$T = \triangle H_0O$$

where T = rate of transpiration

△H,O = difference in the vapou

concentration between ste

matal cavity and free a

outside

rs=stomatal resistance ra=resistance of boundar layer

the transpiration can be retarded by either increasing resistance of stomata or air, decreasing △H_aO of providing additional resistance to vapour at leaf-air interface.

Three types of chemical antitranspirants are known to reduce the transpiration, viz., (i) chemicals which when applied in very low concentration affect the stomatal opening as known as stomata closing type. These chemicals decrease transpiration by increasing resistance of stomata; (ii) chemicals which for thin film on the leaf surface, reductional resistance in the path of water vapour diffusion from leaf to atmosphere, known as film-forming type and (iii) chemicals, which after being an additional resistance in the path of water vapour diffusion from leaf to atmosphere, known as film-forming type and (iii) chemicals, which after being

Kaolinite—an antitranspirant for dryland crops

ROP production in dryland areas usuffers from twin problems of astability and low productivity due o the limited availability of water. n our country about 35 per cent of he net cultivated area falls under uch conditions where annual rainall is less than 750 mm. In these reas crop production completely epends on rainfall. To make the roduction of dryland areas stable nd high, it is essential to inrease the efficiency of the limited vailable moisture. Efficiency of ne available moisture can be inreased if we check the water loss hich takes place through evapora-

tion and transpiration. Apart from moisture conservation in soil through

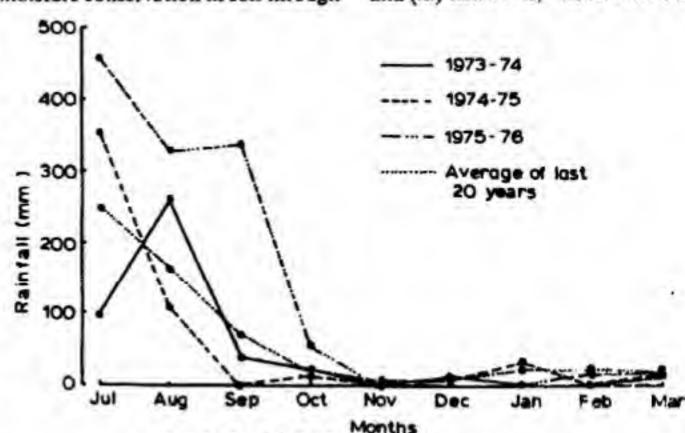


Fig. 1. Rainfall distribution during crop season

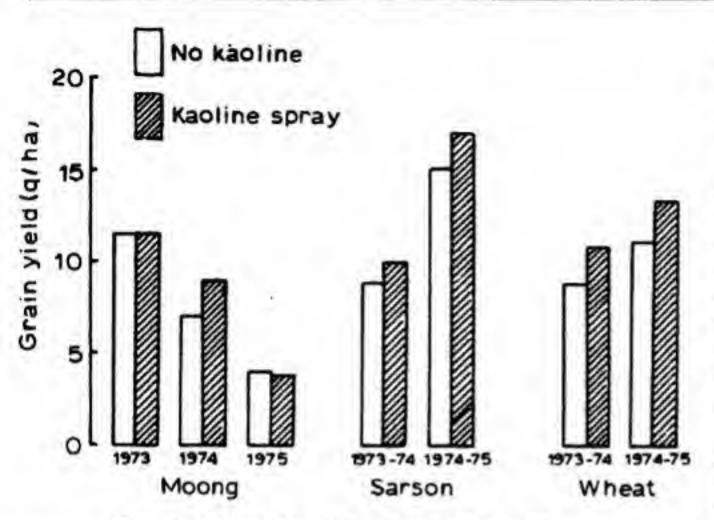


Fig. 2. Grain yield of different crops with Kaoline spray

prayed on the upper surface of the cliage, form a coating which inreases the light reflection of the leaf. These are called reflective type.

Under Indian conditions, because f their inexpensive nature, reflective type materials can be more useful. For this purpose white materials like Kaolinite, hydrated lime, inc sulphate, magnesium carbonate and calcium carbonate can be used a reflective type antitranspirants.

low Kaolinite acts

Kaolinite forms a coating after eing sprayed on the upper surface f the foliage. Being white, it interesses the reflectivity of the leaf, by reflecting some of the solar radiation, the amount of radiant energy vailable for absorption by the leaf reduced, which reduces the heat and on the leaf; lowers down the eaf temperature reducing transpiration, since $\triangle H_2O$ in the above quation is decreased.

ow Kaolinite is used

Kaolinite is a very cheap, white owder available in the market with he trade name of Kaoline. Kaoline when dissolved in water makes the uspension. The suspension of Kaoline of 6 per cent strength is used for forming a white coating on leaf surface. For a crop in one hectare land, where 800 to 1000 litres of water is required, about 50 to 60 kg Kaoline is needed. On small plots, it can be sprayed with pedal or power sprayers and on large scale aircrafts could be used. To make the suspension stick to the leaf surface, a few drops of teopol is used in one-litre of suspension. To evaluate the efficacy of Kaolinite, field experiments were conducted with moong. sarson and wheat crops during 1973-1976 at the farm of Indian Agricultural Research Institute, New Delhi.

Kaoline spray increased grain yield of moong only in 1974. Increase in yield was observed to be about 30 per cent over no Kaoline spray (Fig. 2). No response to Kaoline was observed during 1973 and 1975 when sufficient rainfall was

received. So moisture was not limiting factor in these years wherea during 1974 there was negligible rainfall after August 6 (Fig. 1).

Application of Kaoline was more effective during rabi season as compared to kharif season because of the low moisture content in soil during rabi season. During rabi 1973-74 yield of sarson increased by 14. per cent with Kaoline spray, while during 1975-76 Kaoline spray in creased the sarson yield by 12. per cent (Fig. 2).

Kaoline spray increased the grain yield of wheat in both the experimental years. During 1973-74 yield was pushed up by 27.7 per cen while in 1974-75 percentage increase in yield was only 16.5. Rainfal being lower in the crop growing season of 1973-74, the benefit from the antitranspirant was more compared to 1974-75 season.

It may, therefore, be concluded that in dryland regions of the country where lack of moisture is an important limiting factor, the use of Kaolinite, an antitranspirant, would be desirable to boost crop production. Crops should be sprayed when there is sufficient foliage, i.e, 45 to 60 days in the long duration crops and 25 to 30 days in the short duration crops like moong. In long duration crops, if necessary, two sprayings could be made.

GAJENDRA GIR RAJAT D Division of Agronomy, I.A.R.I New Delhi-I

September-October blooming chrysanthemums

CHRYSANTHEMUM, one of the most popular cut-flowers of the world, flowers only for about six weeks, from mid-November to December end, in the North

Indian plains. It then glut the market, thus giving low return to the nurserymen and cult vators. In order to minimise the glut, the National Botanical Garden





Lucknow has developed a technique of Precision or Programme Blooming through the control of photo-period, extending thereby the blooming period of chrysanthemum by six months, from October to March. The Institute has now achieved another success in this direction, by evolving seven chrysanthemum sultivars which bloom during September-October. The 'autumn barier' has thus been broken.

The development of the seven ultivars involved introduction of ultivars naturally flowering under onditions prevailing during Sepember-October in temperate counries and crossing them with the



varieties genetically adapted to conditions in Indian plains. It was followed by rigorous selection, amongst the progeny of such crosses, for types that possessed the requisite combination of genes, i.e., those conferring earliness of the introduced cultivars and those responsible for adaptability to the North Indian agroclimate. Besides these traits, the new cultivars possess such desirable qualities as vigour, uniform blooming, striking colours (white, pink, terracotta, yellow, deep mauve and magenta) and long life span They belong to Small Flowered Section of garden chrysanthemum and require no spe-



blooming. Since they are hered tarily attuned to flowering during September-October, they would require photo-periodic treatment they were to flower in November December, which is the normal blooming period of chrysanthemum Rooted cuttings of these cultivatively will be on sale during July-August 1976.

Having succeeded in evolving the early blooming types, studies as afoot on developing late-blooming types, i.e. those which would flowed during the months of January February and March.

Right eyed, left eyed

WE are all aware of right or left handed people but few would believe that people also have a distinct bias for one eye. That is, we do not use our two eyes equally. It is known that in tasks such as looking into a telescope there is a distinct preference: 65% people have preference for right eye, 32% for the left eye and 3% are ambicular, i.e., can use both eyes. Point a distinct object with your finger, keep-

ing your both eyes open. Now with but moving, alternatively close one eye after the other. It is interesting to note that the object is aligned with the dominant eye but not to the other. It looks paradoxical to have one dominant eye, but it is true!

According to Stainly Coren of the University of British Columbia and Clare Porac of University of Victoria (Nature, Vol. 260, April 8, 1976), we even see objects somewhat

bigger with the dominant eye. In a study 45 subjects who were pretested for equal acuity of two eyes were studied. Two methods were employed to determine the eye dominance, the point test and the ABC test. The point test required the subject point to the experimenter's nose with his finger while keeping both eyes open. The experimeter, by looking into the eyes of the subject, could note which eye was aligned with the finger. In the ABC test the subject held the wide end of a truncated cone upto his face and viewed a target through a small aperture with both the eyes open. The cone was then opened to find out the eye aligned with the aperture. Repeated several times, it was found that 25 people were right eyed and

20 left eyed.

Now these subjects were allowed to view two white circular targets at a distance of 40 cm through a haploscope to separate the inputs to the two eyes. It was interesting to note that 17 of the right eyed subjects viewed the object bigger with their right eyes whereas 13 of the left eyed subjects felt the same difference with their left eyes.

The researchers point out that as all the individuals had equal refraction for both eyes, the difference in size felt by right and left eyed subjects was only psychological. Though an explanation for size distortion is not clear, it is believed that it may arise from image enhancement in the dominant eye.

ZAKA IMAM



"You know, dad, I am preparing for my test. So, I have collected these fireflies. In these days of frequent power failures the fireflies may help."

version of excitation energy into light energy with simultaneous formation of the ground state molecule (luminescence step), the second is a wellunderstood step. The heart of the chemiluminescence process is the chemiexcitation step-formation of the product in the excited state rather than in the normal ground state. It may be pointed out that the excited state Co, of an atom or a molecule differs from the ground or normal state, C, in the distribution of its electrons only. However, as a consequence of this difference the two states have different shapes, reactivities and energies; the energy of excited state is higher than that of the ground state. The excited and ground states are interconvertible by emission and absorption of energy respectively.

The fundamental chemical reaction involved in the firefly action is the oxidation of an organic compound, luciferin. In the chemiexcitation step, luciferin is oxidised by

DEHYDROLUCIFERNY, L

Mystery of the firefly luminescence

M ANY times we have noticed the nice little sparks emitted by fireflies and wondered about the source of these sparks. Are there tiny batteries tucked away somewhere in the bodies of fireflies? But it seems we have to seek the explanation of the sparks in terms of certain chemical reactions occurring in the body of the firefly. The firefly spark is an example of the general phenomenon of chemiluminescence, i.e., light for which a chemical reaction supplies the energy.

Chemiluminescence is the appearance of light at low temperatures in contrast to the burning of a candle where also a chemical reaction supplies the energy for the appearance of light. Chemiluminescence is a two step process. It occurs when a substantial fraction of the exothermic energy of a chemical reaction (energy evolved when a chemical

reaction takes place) is converted into electronic excitation energy of a reaction product. The reaction product, in the excited state, emits a photon of light to come to the ground state. For a hypothetical reaction where A and B react to give the product C, the two step process will be

← . . step (a) . . →

 $A+B \rightarrow (C+\triangle H)$

← . . step (b) . . →

→C*---C+h

Of the two steps involved in chemiluminescence, viz, (a) use of the exothermal energy of a chemical reaction to produce an excited state (chemiexcitation step) and (b) con-

LUCIFERIN, LH2

molecular oxygen in the presence of in enzyme, luciferase, to give dehytroluciferin in the excited state. The excited state of the product, dehyiroluciferin, emits light to return to he ground state (luminescenece step). Both, luciferin and luciferase, have been studied well. Luciferin was crystallised in 1957 and its structure and synthesis reported subsequently. The enzyme luciferase has a big molecular weight (~100,000). It was crystallised in 1956.

In firefly action, apart from luciferase, ATP (Adenosine triphosphate), Mg*+ ions and dissolved oxygen are necessary. The function of ATP is active to form (enzyme firefly luciferin bound luciferyl adenylate) with a release of pyrophosphate. The actual sequence of steps involved is: the enzyme bound luciferyl adenylate is formed in the first step which can be bypassed if synthetic luciferyl adenylate (LH, AMP) is used. This will react with enzyme luciferase (E) and oxygen to form dehydroluciferin in the excited state [step (a), chemiexcitation] followed by light emission (hu) and conversion of dehydroluciferin (L) to the ground

LH, + ATP-LH, AMP + Pyrophosphate+H₂O

(a) 1 10,+E ELAMP *+H,O

state [step (b), luminescence].

(p) †

L+AMP+E+hu

n the above mechanism, the enzyme luciferase) acts like a conventional atalyst with an interesting ability o handle energy and create an elecronically excited state.

The firefly flash which lasts for early 0.5 sec gives light ifferent colours in different species f fireflies. Chromatographic, absorance and fluorescence studies show nat all natural firefly luciferins re chemically identical. Therefore, ifferences in the colours of light

emitted by different species should be due to some difference in their enzymes, luciferase. This is supported by the fact that purified enzymes obtained from different species emit lights characteristic of the species involved when reacted with synthetic luciferin and ATP. An interesting case of colour variation is exhibited by a species called automobile bug. Light of two different colours is emitted by the two organs, ventral and dorsal, of the same bug. Not only the light from two organs of a bug differs, also different individuals of the same species exhibit colours which differ widely. Luciferin is the same for all the bugs and the colour difference can be traced to difference in enzyme only.

An interesting hypothesis regarding the origin of bioluminescence (luminescence shown by biological systems) has been proposed by McElory and Seliger of Johns Hopkins University, Baltimore. They suggest that the light emitting reactions in organisms developed as detoxi-

fying processes for the removal of oxygen in the struggle for surviva of the early anaerobic (life which i destroyed in the presence of oxygen form of life. Those organisms which could reduce molecular oxygen wer relatively more successful in surviva when small amounts of oxygen star ted "polluting" the biosphere which was originally devoid of oxygen The most successful organisms were those which acquired an enzymatic catalyst, e.g., luciferase, that accele rated the reduction process. Since the redox reaction is highly exothermic, it left the product in an excited state. The excited states are not very stable, therefore the product had to lose energy by some mechanism and come to the ground state. If the specific organic molecule involved was capable of fluorescence, the oxidation reaction would have resulted in what we call bioluminescence.

> B.C. SHARMA PID, New Delhi

Oxygen too is toxic

TF some one is exposed to an oxygen partial pressure (Pp) five or ten times the normal, will he survive? The answer is no. Not only man but other respiring organisms too will die in that condition. Which means that oxygen is toxic at a higher partial pressure? There are living organisms—the obligate anaerobes, which are killed by mere exposure to air. Now, what makes oxygen toxic to obligate anaerobes and respiring organisms at a higher oxygen partial pressure? There are some highly toxic metabolic products of this life supporting gas. To use oxygen for energy yielding and biosynthetic reactions the body possesses an elaborate system of defenses to

control the lethal effects of oxygen. But the margin of safety provided by the defence system is so narrow that a higher concentration of oxygen cannot be dealt with effectively and results in death. The obligate anaerobes, which can live in the absence of free oxygen, lack such a defence system completely. That is why they cannot even resist the normal oxygen Pp in the air.

It is assumed that in the early days of our planet, before life emerged, there was no significant quantity of molecular oxygen. The origin of life, its proliferation and early development, therefore, occurred in anaerobic conditions. With the evolution of blue-green algae the situation

$$0_{2} + \overline{6} \longrightarrow 0_{2}^{-}$$
 $0_{2} + 2\overline{6} + 2H_{2}^{+} \longrightarrow H_{2} O_{2}$
 $0_{2} + 3\overline{6} + 3H^{+} \longrightarrow H_{2} O + OH^{\circ}$
 $0_{2} + 4\overline{6} + 4H^{+} \longrightarrow 2H_{2} O$

Fig. 1

owever changed. These algae were apable of photosynthesis by using later as a reducing agent, utrients from oceans, and the solar nergy from sun, liberating free exygen into the environment. There were then no aerobic organisms. However, the presence of oxygen in the air subsequently changed the ace and direction of evolution.

The accumulated oxygen and the vater on earth posed a threat of the survival of the then existing forms of life. The way out of his situation was to exploit the eactiveness of oxygen for energy ielding and biosynthetic reactions, by developing defenses against its exicity. In the course of evolution with these requirements were met with.

Today we find an enormous diverity of anaerobic and facultative creaures which possess a variety of exygen utilizing reactions in their netabolisms.

To the aerobes oxygen is not an nmixed blessing. The harmful ffects of oxygen are not apparently isible because the defense system is dequate and oxygen in the air is vithin tolerable limits. Experimental tudies on animals and human beings subjected to increased partial ressure of oxygen-have revealed dentical results: increased pressure f oxygen is toxic to all forms of ife, and the severity of symptoms lepend upon the degree of oxygen p. Oxygen is reduced in the body rom O, to 2H,O which requires four electrons. In general, reduction of xygen can occur through monovaent, divalent, trivalent and tetravalent pathways (Fig. 1). If this reduction is to occur by the transfer of pairs of electrons we can expect only one intermediate, i.e., H₂O₂. But oxygen exhibits a distinct preference for univalent pathway of reduction. Therefore, additional possible intermediates are O-, (superoxide) and OH (hydroxyl) radicals. These free radicals are highly reactive and can damage molecular architecture of living cells. They also seem to be the basis of oxygen toxicity. radical O- is the conjugate base of the weak acid HO, the per hydroxyl radical. It undergoes the following dismutation reactions:

0-+HO+OH-+OH+O

of H.O. by iron salts.

The hydroxyl radical (OH·) produced in the above reaction is the most potent oxidant yet known. This radical is the main causative factor in the damage done by ionizing radiation, because it can reach any of the organic substances found in cells. It has been found that the lethality of oxygen is similar to that of ionizing radiation. Irwin Fridovich of the Duke University Medical Centre, Durham (American Scientist, Vol. 63, Jan-Feb. 1975) proposed that the danger of oxygen toxicity lies in the stepwise reduction and then by way of the Haber-Weiss reaction i.e, production of hydroxyl radical. By dismutation reactions and Haber-Weiss reactions (shown above), it is evident that any system which generates O-, will soon accumulate H₂O₂, the H₂O₃ will then react with continuing flux of O-, to generate hydroxyl ion.

Enzymatic defences

Obviously, a system in the body to prevent or minimize the Haber Weiss reaction by scavenging the O-, and H₂O₂, will constitute body defence against oxygen toxicity For this purpose, there are enzymes catalases and peroxidases, which reduce H₂O₂ to H₂O. The catalase use H₂O₃ as both oxidant and reductant, whereas peroxidases use some reductants other than H₂O₃ as given below:

$$H_0O_0 + H_0O_0 \rightarrow 2H_0O + O_0$$

 $H_0O_0 + H_0R \rightarrow 2H_0O + R$

 $H_0O_0 + H_0R \rightarrow 2H_0O + R$ Besides the scavenging operation against H.O., which is the leas reactive intermediate of oxygen re duction, there are also specific enzy mes to catalyse the dismutation o more reactive O, to HO, plu O_s. These enzymes are referred to as superoxide dismutase (SOD) and are known to be present in all res piring cells. So it seems that there are well defined defences in oxygen respiring organisms to resist oxygen toxicity. These defences are pro bably backed up by the activities o antioxidants such as of-tocophero which can minimize the damage don by free radical chain reactions-b breaking them down. But no defence seems to be perfect, and it is presu med that oxygen radicals do wrea some constant low level damage to respiring cells. Cumulative effect of the damage done by the free radical as a cause of old age was suggeste long ago, but the scientists till no were not aware that deleterious fre radicals like O-, and OH can b generated in normal biological oxida tion. In the light of recent researche the free radical theory as the cause of old age should be reexamined mor critically. ZAKA IMA



IEWS & NOTES

Utkal University felicitates Prof. P. Parija

N the occasion of his 85th year celebration on 17 April 976, Utkal University felicitated rofessor Pranakrushna Parija.

Born on 1st April 1891 in a mall village called Ichhapur in the istrict of Cuttack, Orissa, Parija assed the B.Sc. Examination of Calcutta University in 1913 with lonours in Mathematics. Then he ent to United Kingdom for higher tudies after obtaining a Government cholarship in 1914 and was admited to the Christ College of Camridge University. On completion of ripos in 1918, he was awarded the rank Smart Fellowship and started is research career under the guidance f Professor F.F. Blackman, F.R.S., n eminent plant physiologist of ambridge University. After two ears of fellowship he was employed y the Government of United Kingom for a year to find out the best ethod for the storage of apples.

Professor Parija returned to Orissa 1921 after seven years stay in Ingland and joined Ravenshaw college, Cuttack as Professor of totany in Indian Educational Serice. He then became Principal of avenshaw College, first Vice-chancellor of Utkal University, Profice-Chancellor of Banaras Hindu Iniversity and again Pro-Vice-Chancellor and then Vice-Chancellor of Utkal University until he retired 1966.

Professor Parija's contribution to

He was elected General President of the Indian Science Congress Association, of which he was previously the General Secretary for five years, to preside over the Bombay session held in January 1960. He was elected Vice-President of the 10th International Botanical Congress held in Edinburgh in August 1964.

While in U.K., Professor Parija studied the respiration of stored apples with Professor F.F. Blackman. His findings are still considered fundamentals of plant respiration. Returning to India, he developed the botany department of Ravenshaw College, Cuttack. He attracted students from all over India and Ravenshaw College soon sprang up as an active centre of research in botany, particularly in plant physiology. He conducted experiments on respiration of plants, control of obnoxious weeds, transpiration and heat resistance of plants, experimental morphology, resistance of rice to flood, drought and saline conditions, etc. He also investigated the algal flora of the Chilka Lake of Orissa and made a survey of the bluegreen algal flora of the soils of Cuttack.

Professor Parija was elected in 1952 general election as an indepen-



Prof. P. Parija

dent member to the Orissa Legislative Assembly from Balikuda.

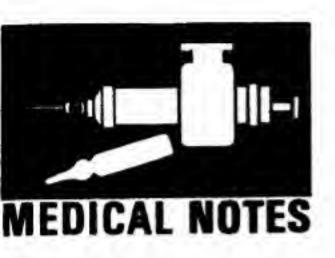
As a mark of honour, Post-Graduate Botany Department of Raver shaw College has been name "Parija Post-Graduate Department of Botany" and a hall has been constructed and named "Parij Hall". At 85, he carries his year lightly and is still active intellectual and physically.

DINABANDHU MISHR MANORANIAN KA Parija P.G. Deptt. of Botan Ravenshaw Colleg Cuttack 753003 (Oriss

International committee for solvent extraction chemistry and technology

A S a result of discussions held during the International Solvent Extraction Conference ISEC 1974 in Lyon, France, in September 1974, steps have been taken to form an International Committee for Solvent Extraction Chemistry and Technology. The object of the Committee is to encourage the development of the science and technology of solvent extraction through improved comm-

unications on an international basis. The committee hopes to co-ordinate the organisation of major meeting and also assist with projects such as rationalisation of nomenclature. The first Secretary General of the Committee is Professor C. Hanson Schools of Chemical Engineering University of Bradford, Bradford West of Yorkshire BD7 ID1 England.



Antileukemic principle isolated from plants

ROM ancient times, plants of the family Euphorbiaceae have been sed to treat cancers, tumours and arts and references of their use are ound in literature of folk medicine f many countries. On the basis of nis information, Dr. S.M. Kupchan nd his associates in the Department f Chemistry of the University of irginia at Charlottesville, looked for ntitumour and antileukemic princiles in plants of the family Euphoriaceae and recently reported the isoation and characterization of antiukemic principles from Euphorbiasula L and Croson tiglium L., two nembers of that family which are mong those used widely in folk nedicine (Science, 191, 571, 1976). he solvent extracts, upon purificaon, showed antileukemic activities gainst the P-388 lymphocytic leukenia in mice. Systematic fractionaion of the extract from Euphorbiasula L. led to the characterization f a major antileukemic component, s the new diterpenoid diester, ingenol ,20-dibenzoate. Similar fractionaion of Croton oil led to characteriation of phorbol 12-tiglate 13lecanaote as an active principle. The efficacy of these principles in numan leukemia are now under tudy.

BRAKTI DATTA

Women over forty have a greater risk from pills

MOMEN over the age of 40, who take oral contraceptives, face a risk of death much greater than that associated with any other method of birth control, including abortion. In fact, the analysis showed, for older women using the pill, the mortality risk is higher than if they had used no birth control at all and faced instead the dangers of resulting pregnancies. For women below the age of 40, however, the findings indicate that the risk to life associated with the pill is much lower. For women under 30, the risk is not much different from that accompanying the use of IUD (Intra-uterine device), condom, diaphragm or legal abortion performed during the first 12 weeks of pregnancy.

The analysis was released recently by the Planned Parenthood Federation of America, which was prepared by Dr. C. Tietze, an internationally known expert on contraceptive and pregnancy hazards, and Dr. J. Bongaarts and B. Schearer. This seems to be the first study to assess the relative risks to life from the various fertility control methods according to the age of the women.

The study concluded that, except for women over 40 who use the pill, the known mortality risk associated with the use of any of the major methods of fertility control-the pill, IUD, condom, diaphragm, early abortion and sterilization—is very low, as compared to the risk

of death from pregnancy and child birth when no fertility control method is used. It was further showed tha for women of any age during the child-bearing years, the lowest risk to life is associated with the use of the condom or diaphragm, with early abortion as a back-up for any pregnancies that result. Depending upor what age they start, women using this approach could expect to need one to three abortions during the course of their reproductive lives.

In an accompanying comment or the implications of the study, Tietze and F.S. Jaffe, president of Planned Parenthood's Alan Guttmache Institute, point out that for women under 40, the known risk of death using any current means of fertility control is lower than the risk from automobile accidents. But, they emphasized, there is no method tha is entirely free from risk and urged more research to develop safer a well as effective birth contro methods.

Finally, the authors of the report also noted that concern about risks to health is not the only, and pro bably not the major, factor, deter mining the consumers' choice among methods of fertility control. Amon other important factors they listed are effectiveness, convenience of use reversibility, moral and ethical consi derations, life-style and finally th

R. RAGHUNATHA

Estrogen is linked to uterine cancer

STROGEN hormones are taken L by millions of women all over the affluent countries to relieve symptoms and afteroffects of menopause. These hormones are als used as replacement hormones to sta feminine and to ward off ravages

(Continued on page 39



Light and its nature

most important parts of physical science, because most of our nowledge of the world around us is ained through vision. There is no isible link between our eyes and the bjects seen, still something from the bjects reaches our eyes, which reates the sense of vision.

We learn the properties of giant tellar systems by means of light that ravels for millions of years through the empty space to deliver its message o us. We can know the properties of atoms from the light emitted by them, which gives us the hidden information concerning their internal tructure. In fact, most of the information we get in our day-to-day ife is obtained through the medium of light.

What then is light? Scientists have always been puzzled by its nature. There are a number of heories on light: (1) corpuscular heory, (2) wave theory, (3) electromagnetic theory, and (4) quantum of photon theory. All the theories are evaluated briefly and range of their applicability is discussed.

Corpuscular theory

According to the corpuscular theory, a luminous body is supposed to emit tiny particles of extreme minuteness. They are projected from a luminous body with enormous speeds in all directions and in

straight lines and stimulate our sense of vision when they impinge on the retina of the eye. The English physicist and mathematician Sir Issac Newton (1642-1727) was the exponent of corpuscular theory of light. He first showed the composite characteristic of white light from sun or other sources.

This theory explains the rectilinear propagation of light, formation
of shadows, reflection and many
other optical phenomena, but it
breaks down as it begins to explain
the phenomena of refraction, double
refraction, interference, polarisation
and diffraction. In explaining refraction, however, Newton had to
suppose that the velocity of light in
an optically denser medium is greater than the air, but later this was
found to be invalid.

Wave theory

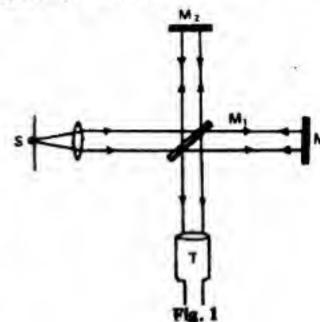
The wave theory was first formulated by the great Dutch physicist Christian Huygens in 1878. This theory supposes that a luminous body by its rapid vibratory movement sets up disturbances or waves in a mysterious, all pervading medium, called 'light ether', 'world ether' or more simply just 'ether', which travels with the velocity of light in all directions in the form of transverse waves. These waves when falling on eyes produce the sensation of sight.

Huygens was the first to state the

wave theory in a definite form. H satisfactorily explained the pheno mena of reflection, refraction an double refraction but could no account for the rectilinear propaga tion of light and the theory of for mation of shadow, which were s easily explained by the corpuscula theory. The theory became unpopu lar for about a century. It was activated in 1800 by the Englis scientist, scholar and engineer Tho mas Young (1773-1829), when I explained the principle of inte ference which remained inexplicab by the corpuscular theory.

The French physicist Augusti Fresnel, a contemporary of Thoma Young, by taking the transvers characteristic of the light wave re moved the objections against th wave theory. The transverse cha racter of light satisfactorily explain ed wave polarisation, diffraction and many other optical phenomen The wave theory also gives sati factory explanation of the colour of the spectrum. Thus the work of two contemporary scientists. Your and Fresnel, led the corpuscula theory to an end bringing the way theory into prominence in the earl part of the nineteenth century.

It was possible using wave theory to explain the phenomena of interference, diffraction, polarisation double refraction, but Huygen theory had one serious drawback that of assuming the existence of hypothetical elastic fluid known a 'ether'. This is, because the result of Michelson-Morley's experiment completely upset the idea of existence of 'ether'.



In 1887, A. A. Michelson, an merican physicist and his co-worker .W. Morley, carried out an experient which was expected to measure he speed of the earth's motion with espect to ether. They arranged an iterferometer as shown in Fig. 1. beam of light from a source S ills on a half-silvered mirror M, hich reflects half of the beam in the irection of mirror M, and passes ne other half in the direction of irror Ma. After being reflected from nese mirrors, the beams return back mirror M, half of the beam from irror M, penetrates the thin silver yer on M, and reaches the telecope T, and half of the beam from is reflected by mirror M, into e telescope T, where they are bserved. They set up interference inges in the telescope. It is possile to determine the difference in ath between the two beams by bserving these fringes.

If the apparatus moves with resect to ether in the direction M, M,
appears that light takes slightly
inger time to traverse the path
I,M,M, than the path M,M,M,
his results in a greater number of
aves in the first path and a conseuent displacement of the observed
inges. If, on the other hand, the
otion with respect to ether is along
the direction of M, M, the situation
reversed, and the fringes displace
the opposite direction.

To compare these cases, Michelson and Morley floated their apparatus a tank of mercury so that it could be tate slowly. They expected to and a displacement of the fringes as rotated from one position to nother position 90° from the first. They failed to notice any displacement of expected order of magnitude. The result suggests that the effects of the ether are undetectable. It is suggests that the speed of light independent of the motion of the ource or of the observer.

Electromagnetic theory

In 1864, a British mathematical physicist James Clerk Maxwell put forward the electromagnetic nature of light wave. From theoretical considerations he predicted that the velocity of the electromagnetic wave

would be $\frac{1}{\sqrt{K\mu}}$, where K = specific

inductive capacity and #=permeability of the medium. Maxwell's theoretical equations were experimentally confirmed by a German physicist Heinrich Hertz in 1888 and the study of light became a branch of electricity.

According to this theory, all types of radiations are electromagnetic in nature. An electromagnetic radiation, visible or invisible, consists of an electric force and a magnetic force, set up in the surrounding medium at right angles to the direction of propagation of the radiant energy. When the electromagnetic waves of definite wavelengths pass through the lens of eye and strike the nerve ends, the pulsation setup proceeds along the optic nerve to the brain and we experience the sensation of seeing.

Certain remarkable developments have occurred in the field of electromagnetic theory in the post-Einstein period which suggest that the light wave may be considered as

a lump of vibrating electromagnetic field flying freely through empty space. At first glance it seems that there is a lot of difference between the light waves and the radio waves, but they are the same thing-electromagnetic waves which differ only in their frequencies. It has been possible to explore an enormous spectrum of electromagnetic radiation, over a wide range of frequencies and wavelengths, all having the same velocity in space as predicted by Radio waves, infrared Maxwell. rays, visible rays from red to violet, ultraviolet rays and X-rays are all radiations of the same nature but cause different effects. They are all electromagnetic radiations or waves, because experiments have shown that each of the radiation must have electric and magnetic components, and the different electromagnetic waves are characterized by different wavelengths or frequencies. Range of electromagnetic radiation is shown in Table 1.

The electromagnetic radiation visible to our eyes extends only to a small portion of this great range, one end of which is occupied by the red light having a wavelength of about 7.5 × 10⁻⁵ cm (frequency=4 × 10¹⁴ hertz) and the other; the blue-violet end of the visible range has a wavelength of about 4 × 10⁻⁶ cm (fre-

Table 1. Electromagnetic radiations

Туре	Frequency	How it is produced
50 Cycles	50 hertz.	The weak radiation from alternating- current circuits
Radio, radar and TV	104-101 hertz.	Oscillating electric circuits
Microwaves	10	Oscillating currents in special vacuum tubes
Infrared	1011_4 x 1014 hertz.	Outer electrons in atoms and molecules.
Visible	4×104_8×104 hertz.	Outer electrons in atoms
Ultraviolet	8 x 1014-1017 hertz.	Outer electrons in atoms
X-rays	1014—1014 hertz	Inner electrons in atoms, and sudden deceleration of high-energy free electrons
Gamma rays	10 ^{ts} —10 ^{ts} hertz	Nuclei of atoms, and sudden deceleration of high energy particles from accele- rators

s considered as that part of the elecromagnetic radiation which proluces the sensation of vision upon the human eye. From the physical coint-of-view, the only difference between an ordinary electromagnetic wave and a light wave is the waveength, which is very small for light waves detected by the human eye, and large for ordinary electromagnetic waves detected by a radio receiver.

Though the electromagnetic theory of light satisfactorily explained the propagation of light, interference, liffraction, polarisation and many other optical phenomena, it failed o explain the process by which ight is emitted or absorbed by mateial bodies. Observations of the photoelectric effect presented great difficulties for the understanding of lectromagnetic radiations from the lassical point-of-view. However, he experimental evidence of photoelectric effect could be satisfactorily explained by Planck's new idea of nergy quanta.

Juantum theory

German physicist Max Planck, a 1900, postulated a revolutionary heory called the quantum theory. According to the quantum theory, beam of light consists of discrete bundles' of energy of 'quanta'; the mount of energy in each quantum dependant on the frequency of the abandoned corpuscular theory at in a new form.

One quantum of light energy is sually called a 'photon'. The rays it the sun, according to Planck's lew, that pour into a room through the windows or the light of a lamp to not represent a continuous flow ight waves, but rather a stream of dividual photons. A photon is unit of electromagnetic radiation aving a certain wavelength and

frequency, and also having a certain definite amount, or quantum, of energy. Planck proposed that photons of different frequencies carry different quanta of energy and that the energy of a photon is directly proportional to its frequency.

Writing f for the frequency of the photon and E for the quantum of energy it carries, we can express Planck's assumption as E = hf, where h is a universal constant known as Planck's constant whose value is 6.626×10^{-17} ergs second.

Since radio waves have low frequencies, their quanta of energy is small. Visible light, with frequencies a billion times greater, comes in quanta whose energy is also a billion times greater. Moreover energy must be absorbed and emitted in whole quanta exactly, no fractional parts of quanta are allowed.

In a paper, published in 1905, Albert Einstein indicated that the observed laws of photoelectric effect can be understood, if one assumes that electromagnetic radiation propagates through space in the form of individual energy packages called photons, and that, on encountering an electron, it communicates to the electron its entire energy. So more intense light means that more light quanta of the same kind fall on the surface per second. As a single photon can eject one and only one electron, the number of electrons must increase correspondingly. According to the quantum theory homogenous light contains photons of a definite energy. The energy of the photon for the red end of the spectrum is half that of the violet end.

The quantum theory has met spectacular success in explaining all facts about the atomic structure, spectra, emission of electrons from the metal, and in fact all the phenomena connected with interaction of matter and energy. But phenomena like refraction, interference, diffraction, polarisation and certain other facts lend themselves for easy explanation in terms of electromagnetic wave theory. However, there are phenomena which can be explained by the wave theory but not be the quantum theory. The bending of light around obstacles is a typical example. There are also phenomena which can be explained by the quantum theory as well as by the wave theory.

Then what really is light? Is light a wave or a shower of photons? The dual aspects of radiant energy, the wave aspect and the particle aspect are often combined in one as the Wavicle (wave-particle) theory.

This theory suggests wave proper ties of light as manifest in the pheno mena of interference, diffraction and polarisation. It also suggests ligh as a stream of particles called photons, which have zero rest mas and travel at a velocity equal to that of light in free space. Photon mus often be given a dual character as a wave or as a particle to explain satisfactorily certain experimental observations. The wave properties of light predominate at low frequencies, the corpuscular properties predominate at high frequencies. How energy can behave as corpuscles and as waves under a different set of things is the subject matter of an important but rather difficult branch of modern theoretical physics, known as wave mechanics, or quantum mechanics.

The present accepted value of velocity of light in free space is $C=(2.997925\pm0.000003)\times10^{10}$ cm/sec. The velocity of light is the upper limit of velocities for all material bodies. The simple mechanical law of addition and subtraction of velocities is not valid or, more precisely, is only approximately valid for small velocities, but not for those near the velocity of light. Einstein's theory of relativity suggests that it is

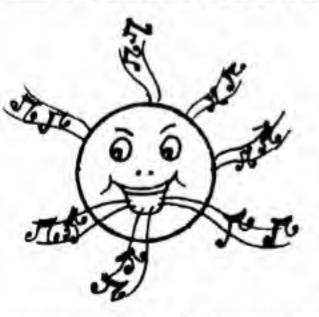
npossible to exceed the velocity of ght by adding two (or more) veloties, no matter how close each of nese velocities is to that of light. he velocity of light, therefore, assumes the role of some kind of universal speed limit which can never be exceeded. Careful measurements also show that c is independent of intensity of light and also of the presence of other electric and magnetic fields.

P.K. BANIN Science teacher, Victoria Schoo Kurseong (W. B.

Clippings from astronomy

Sun too sings

HENEVER any object vibrates it produces sound which may remay not be audible to a human ar. Whenever earthquakes shake he earth, it also vibrates, but the bund is never heard. Similar is the ase with our special star, the sun. secause of the violent activities had, sun vibrates at half a ozen frequencies simultaneously. Ithough no one has been able to ear the sound the sun produces, the stronomers have, to say simply, laimed that the sun is singing a song-



Henry A. Hill of the University of Arizona, U.S.A., is the astronomer who found the sun singing though the is still uncertain whether the ong is classical, semi-classical or top. Just as from the type of song, the voice, the music, the person who is singing and his musical accompaniments can be judged, by hearing what is known as 'solar song' astronomers can estimate the nature,

composition and the nuclear reactions taking place inside the sun. The origin of the song has been attributed to acoustic waves. These waves travel to and fro, from one edge of the solar disc to another at a speed nearly 200 km/sec, for periods ranging from 10 to 48 minutes. The amplitude of 'disturbance' they produce on the surface of the sun is less than 10 km.

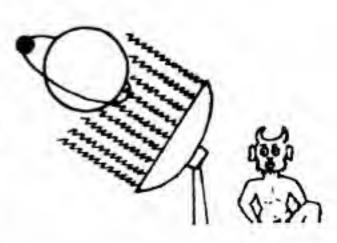
It is envisaged that the song may help in correcting the present models of the solar interior. The major flaw in them that the theoretically calculated and observed values of solar neutrinos do not tally may be removed.

A breakthrough

UNTIL recently, astronomers believed that even the biggest telescope could not amplify a star in heaven with the exception of the sun to a size more than a point. A group of astronomers at Kitt Peak National Observatory has, however, achieved a breakthrough by using a novel technique. The faint image of the star Betelgeuse, having a diameter 800 times of the sun, was magnified by means of an image intensifier, and the remaining haziness in the photograph was deducted by using a computer. What they found was surely surprising but not unanticipated. The surface of this biggest star is similar to that of the sun. It is mottled indicating that some convection process is prevalent there also, as on the sun.

Communication with the other worlds

OMMUNICATION with an ex C traterrestrial civilization will be possible only if our receiving systems and their transmitting systems are tuned to the same radio channel. Wha should be that radio channel?-is the crux of the problem. The situation is similar to that of a stranger who phoned you that he shall be meeting you in the evening but forgot to tel you the rendezvous. To this date whatever serious efforts have been made (S.R. Jan., 76) to identify a radio signal from the outer space all have been confined to seeking i on a frequency of 1,420.405 MHz This is the frequency of neutra hydrogen, the most abundant atom



in the universe. It has been selected in the same manner the most probable place, eg., Connaught Place, a strange would select to meet you in a place like Delhi. Recently, however, some more frequencies have been thought of and proclaimed as more potential than the previous ones. The above frequency for the communication, it s now claimed, is not useful, for, in the galactic plane, the radio channel 1,420.405 MHz is very noisy. Moreover, the minimum "sky noise" is in the channel some thousands of MHz, which is closer to 1,667.358 MHz, the principal transition frequency of OH. For the selection of "natural frequency" out of the frequency band between the frequencies of H and OH-just as the selection of the most probable popuar place a stranger would select for rendezvous-Bernard M. Oliver of Haward Packard Company, U.S.A., has a suggestion. He has suggested 1,652.418 MHz channel for comnunication. It is the approximate requency of the centre of mass of water molecule.

Another "natural frequency" claimed is 56,000 MHz (approx.). which is the unique intersection of wo fundamental sources of noise—he black body background radiation and the quantam noise of radiation. This frequency is not available on earth as the strong oxygen lines are to near as to obliterate it. The earch for a radio signal from outer space on this channel will be possible only when telecopes will be installed in space.

Galileo's rival

Galilei Galileo, that great Italian nathematician and astronomer who nvented the telescope, was during is life-time condemned by his conemporaries and so passed a life full of destitution, humiliation and men-

tal agony. That is why, perhaps, nobody then wanted to be a Galileo and possibly why a contemporary of Galileo, who equalled him in scientific thought and inventiveness, did not become one. That unknown, quite a new name today, recently unearthed by a British historian is Thomas Harriot, proclaimed as the "Britain's greatest mathematical scientist before Newton."



After nearly a century and half of Harriot's death, some 7000 pages of his notes—obviously unpublished were discovered and have been found of utmost scientific importance. Like Galileo he had not only turned his telescope towards the heaven to study moon, sun, comets, satellites of Jupiter, etc., but also made outstanding contributions to the knowledge of physics and mathematics. He calculated the ballistic path of a projectile under the influence of gravity, derived what is now known as "Snell's law" in optics, introduced signs for greater than (>), less than (<), and dot (.) for multiplication in</p> mathematics.

Born at Oxford in 1560, Harriot was an arts graduate from Oxford University and a scientific adviser to Sir Walter Raleigh.

DILIP M. SALWI

negative number.

The trick usually employed in proving absurdities like l=2 of 2>3, etc., is either a disguised division by zero or a non-reversal of the sign of inequality in spite of (disguised) multiplication of unequality the same negative quantity.

In the following 'proof', though neither of the two aforesaid 'illegal operations has been used, there another fallacy. Can you detect it?

To prove 1>2. Proof: Since 4>2

Taking logarithms of bot sides to the same base 'a', w have log_4>log_2 Take a= 1 whence we have $\log_4 > \log_2$ Let us now evaluate log, and log, 2 from first principles, viz., $a^{x} = N \leftrightarrow X = \log_{\bullet} N \ (N > 0.$ $a > 0, a \neq 1)$ Let log 4=X and log 2= $4 = (\frac{1}{2})^{X}$ and $2 = (\frac{1}{2})^{Y}$ (definition) $\therefore 4^{1} = (4^{-1})^{X}$ and $2^{1} = (2^{-1})^{Y}$:. 41 = 4-x and 21 = 2-1Y $\therefore l = -X \text{ and } l = -2Y$ (since $a^X = a^Y \rightarrow X = Y$ if $a \neq 1$) X=-1 and Y=-1 $\log_1 4 = -1$ and $\log_1 2 = -1$ Substituting these values i I, we get -1>-1 :.2 (-1)>2 (-1) :.-2>-1 $\therefore (-2) (-1) < (-1) (-1)$ i.e., 2<1 :.1>2

Where is the fallacy?

T is a common knowledge to any one knowing elementary lgebra that (i) division by zero is

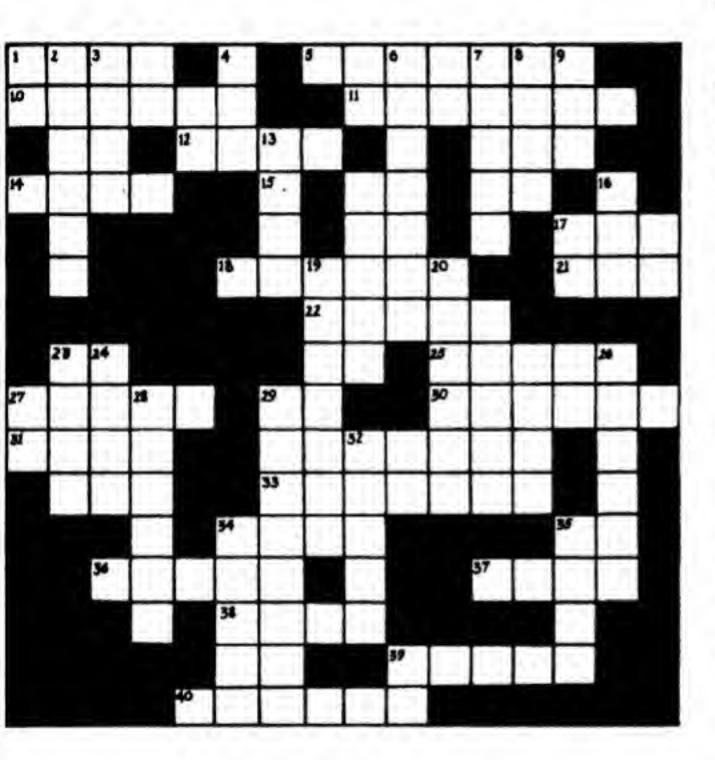
not permissible; and (ii) order reversal is effected on multiplying both sides of an inequality by the same K.P. JANARDHANA!

Univ. of Bomba;

Bomba;

See the fallacy on page 417

Science Crossword Puzzle (Food and Nutrition)



CLUES

CTOSS

- Ideal food for infants and children and a good supplementary food for adults.
- 5. Sugar of milk.
- A nutritional deficiency disease due to dietary deficiency of iodine.
- Vegetable which contains a chemical that causes goitre.
- A millet rich in calcium, phosphorus and iron.
- A planned food.
- A cereal substitute for sick and convalescent.
- Modern food technology uses this vegetable source for preparation of milk and butter.

- —carbohydrate diet is prescribed for diabetics.
- 22. A good source of citric acid and vitamin C.
- A delicious fruit for the thirsty in summer.
- 27. Staple cereal food of north India.
- A common deficiency disease of poor women during pregnancy.
- 31. Food of the Eskimos.
- 32. Chewing leaf.
- Vegetable fat rich in unsaturated fatty acids.
- A common bulb used in cooking.
- 37. Its deficiency leads to anemia.
- 38. Fermented milk.

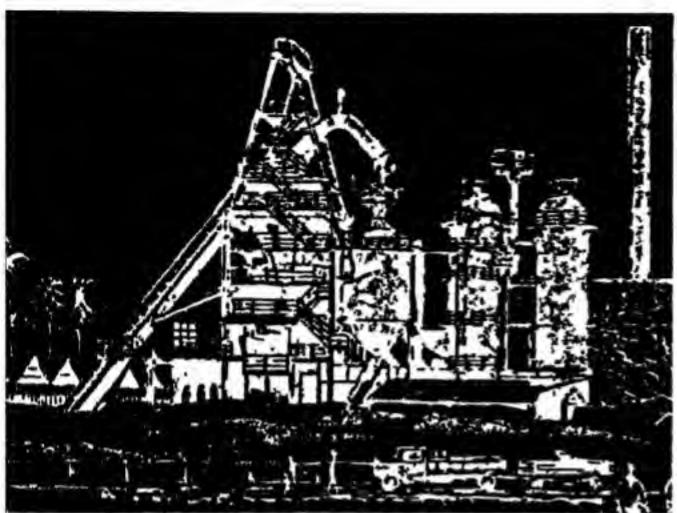
- A fruit rich in pectin and vita min C (starts with the lette G).
- 40. Chief protein of milk.

Down

- Element necessary for the synthesis of a hormone.
- Food is the prime necessity
- 4. A common beverage.
- Element essential for bone formation.
- 7. Over indulgent in food
- Excessive intake of this substance should be avoided by hypertensive people.
- Nutritionally rich source which also contains an anti-vitamin.
- 13. Fat of the milk.
- 5. Milk supplied through gove dairy farms is usually—
- An international organisation concerned with nutrition.
- Appetiser in optimal amount but harmful when taken in excess.
- A good source of iron, com monly used in soups.
- 23. Watery part of milk.
- 24. A non-vegetarian's delicacy.
- 26. Pellagra preventive factor.
- 28. Nut used in preparing halwa.
- Grown in plenty in coasts areas, common ingredient of 'Chatni'.
- 32. An ideal breakfast,
- Commonly used in malt beverages.
- A source of vegetable milk.

G. RAJAGOPA K. VENKATESA Deptt. of Biochemistr

JIPMER, Pondicherry-60500



SCIENCE IN INDUSTRY

Lead acid battery charger

A charger for lead acid batteries has been developed at the lational Aeronautical Laboratory. angalore This charger is different rom other charges in that the chargng current automatically adjusts self proportional to the state of scharge of the battery, ie, unlike ther chargers the current need not e manually adjusted. This not only ives man-hours but also extends the fe of the battery. As a battery is eing charged the charging current radually decreases from 10A, and ven if the charger is left connected the battery for a number of days thout attention it will not be overharged, by more than 10% which allowable.

As no large inductance, saturable

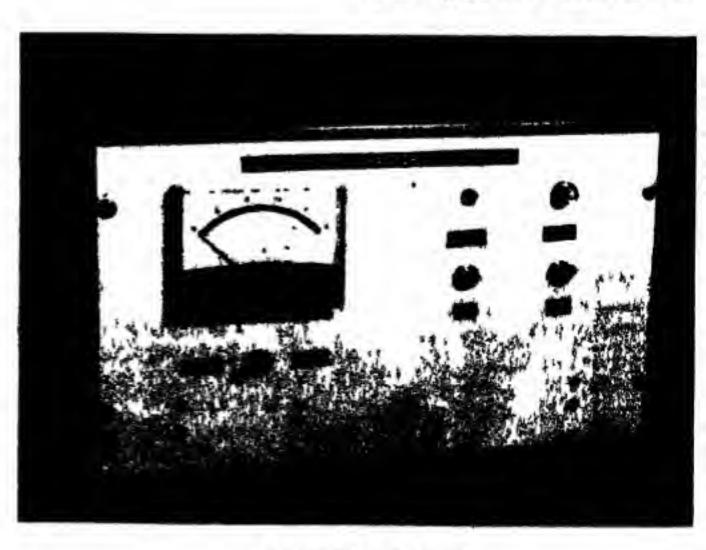
reactor or capacitance is used in the circuit, the size is very small, 32. cm × 25.4 cm, for a 12-36V, 10. battery charger, and hence it portable.

A phase controlled silicon controlled rectifier is used as the serie element to control the current UJT senses the battery voltage compares it with a reference an produces trigger pulses for the SCR

The charger is inherently short circuit protected, so that the output terminals may be short-circuite accidentally without causing and damage to the charger—as no current will be drawn through the short circuit

Improved wick stoves

K available in the market is various sizes using same number of wicks but arranged around different diameters. In spite of less cost and being easy to operate, they are not very popular. It is because of the lower efficiency and heat release rates compared to pressure stoves resulting in slow heating of materials.



Automotic bettery charges

The Indian Institute of Petroleum, the Petroleum, the Petroleum, has developed a kerosene ick stove having thermal efficiency of 60% at kerosene consumption ate of 145 gm/hr; the thermal ficiency is 15% more than the inventional wick stoves. It is due incorporation of the following

design modifications:

(a) Raising the wick to get more oil burning, (b) Increase in height of sleeves, (c) Optimization of air perforations, (d) Provision of a heat-conserving ring, (e) Providing a layer of heat insulation on the upper surface of oil container.

Small capacity water tank in ferrocement

MUCH of the building construction activity at present is based in the use of reinforce concrete which tilizes steel and cement in large quantities. The use of ferrocement, on the other hand, results in considerable savings in these materials. It is made up of wire mesh and cement mortar and a small amount of mild steel reinforcement. It offers an



elegant, economical and lighter all ternative for structural applications reducing the dead weight of the structure and thereby resulting is lighter foundations. It results is overall economy in building construction. Some of the advantage of ferrocement are listed below:

- 1 Ferrocement combines the light ness of steel with the mouldabilit of concrete. Very thin structure can be designed for long spans
- 2 It has a high degree of impermea bility.
- 3 Unlike reinforced concrete, ferror cement functions as a homo geneous material and its behaviou is therefore akin to that of steel
- 4 It is possible to dispense with formwork altogether in building large span roofs if precast ferro cement components are used.
- 5 It possesses high extensibility and hence does not crack at lov tensile stresses.

The uses of ferrocement are in the construction of buildings, wate tanks, grain storage silos, septitanks, etc. Prefabricated ferrocement water tanks of moderate capacities are ideally suited for use in village and in small communities.

The Structural Engineering Re search Centre, Madras, has develop ed designs for ferrocement water tanks of upto 10,000 litre capacity Designs have been perfected afte extensive laboratory tests on the performance of the tanks. Fo 5,000 and 10,000 litre capacities, the sides of the tanks are only 3 cm thick A 5,000 litre tank is 1.88 m in dia. 1.80 m high, and weighs about 1. tonnes. A 10,000 litre tank is 2.3 r in dia., 2.4m high, and weighs about 2.5 tonnes. The cost of the tan works out to 18 paise per litre fo 5,000 litre capacity and 17 paise pe litre for 10,000 litre capacity, ex cluding the cost of the supportin structure.



cience Annual, 1976, Executive Editor: Arthur G. Tressler, Field Interprises Educational Corporation, Merchandise Mart Plaza, Chicago, Ilinois, 60654, Pp. 432, \$6.95.

IKE its predecessor, this superbly produced 1976 volume, ontains 16 special reports, a science le of 46 articles, two fascinating tories on research scientists and their work and the usual awards to those who have achieved distinction. With america celebrating its Bicentenary, special feature on the first 200 years of American science by a noted istorian, Prof. Hunter Dupree, ounds off this admirable work.

The reports are as diverse in their opicality and contents as are the lazing coloured photographs inluded in them. They range from narine zoology, linked with the nystery of the fleshy lipped manatees which evolved from land mammals nillions of years ago; revelations in he Atlantic Ocean floor; and predicion of earthquake from sensitive eismographs and nervous animals; lown to baffling natural disasters, ewer forms of energy production, ediatrics, increasing food through ertilizers, development of electron nicroscopy, social anthropology. ghting unknown viruses and a surey of astrophysics and newer subaomic particles. The report on a new anning electron microscope for aree dimensional images contains pecial coloured photographs which ring in vivid 3-dimensional variety f features when viewed through e red/green cardboard applied in this volume.

What is not included in these reports comes up in the form of short articles in the 'Science file', with its fascinating array of topics. There is, for example, a description and photograph of 'beefalo', a cross breed of buffalo and beef cattle, which thrives on grass and produces less costly meat; discussion on how to make fuel burn better by adding water to oil and gasoline; advances in controlled thermonuclear fusion and progress in transportation through the resurgence of the dirigibles.

Few intelligent readers would be unaware of the splendid work undertaken by the Leaky family in the field of anthropology in East Africa's Olduvai Gorge. Here they found the fossils of manlike species which lived about 2 million years ago. This clue have set a trail to investigate deeper into the existence of homo species. A special article discusses their work, their family and their life in this remote African site. The other special article surveys the work of a 36 year old astronomer James E. Gunn, who has already made a mark in cosmology. As Prof. of Astronomy at the California Instt. of Technology, Pasadena, and a staff member of the Hale Observatories, he probes deeper and farther into space and tries to explain the mystery of the quasars creating more controversies than solving them.

Written with care and lucidity, this volume should be read and studied by students, scientists and the lay intelligentsia.

S.K. GHASWALA

MOLECULAR TRANSFORMA-TION IN ORGANIC CHEMISTRY —AN INTRODUCTION by D. Ranganathan and S. Ranganthan, Macmillan Company of India limited, New Delhi (1975), Pp. 68, Rs. 16.00

DURING the last two decades, the study of reaction mechanism at molecular level has gained considerable importance and he provided a clear understanding of the chemistry of organic synthesis. The book under review discusses the reaction mechanism in a refreshing manner with the help of about twentorganic reactions including Volume Richter reaction and Bayer's indiges synthesis.

The authors candidly illustrate that one can logically find out the steps of an organic reaction with the help of careful analysis of the principles of bond adjustments, with out resorting to 'arrow pushing' of intuition. The Von Richter reaction is one of the examples where the have shown how both logic and painstaking experiments can work out the steps. Ranganathans humo rously call this reaction a 'brillian piece of detective work.'

The discussion on 'ATP-imidizole cycle gives an impression about the fascinating ways of nature. Indeed nature, the master craftsman, with the immense wisdom gained from vast experience, brings about the transformations which even a brillian organic chemist cannot carry out be experiments.

Illustrations of strange product which arise while making an by suitab breaking of bonds reagents have been included i a chapter entitled 'The humorou side of bond making and bon breaking'. The principle of prepara tion of many useful compounds mor economically in the laboratory tha extracting them from natural source have been discussed. In this contex indigo synthesis as an example is di cussed. The Woodword-Hoffman rules have been intelligibly explaine with various examples in the penult mate chapter. The last chapte entitled 'For your enjoyment only contains a number of problems for the readers to solve and is intende to stimulate the judicious use of th basic principles of reaction mecha nism.

The book, written in a lucid style will be a pleasant experience for thos who are familiar with basic organic reaction mechanism. It will be cerainly a welcome addition to all ibraries. But, it will not be impertinent to mention here that in a country ike ours, where students cannot afford to purchase text-books, the book for its high price will stay beyond their reach.

ALOK R. RAY
Deptt. of Chemistry
University of Delhi
Delhi-110007

PERIODIC CLASSIFICATION by P.L. Soni and H.C. Sharma, Sultan Chand & Sons, Daryaganj, Delhi-6, Pp. 254, Rs. 12.50.

topic in every subject necessitaes the demand for monographs to
meet the requirements of students of
idvanced courses. The monograph
inder review, which deals with seleced topics in chemistry, is an attempt
in this direction. The book consists
of two parts: first part contains
chapters (1-4) and second part chapers (5-6).

The first three chapters deal with the heory of structure of atom from the arliest time to the present. Chapter describes the historical developnent of the structure of atom from Dalton, who considered atoms to e small, hard and indivisible partiles, to Bohr who gave the quantum nechanical description of the same, mown as the old quantum theory. Chapter 2 describes the structure of tom on the basis of wave-mechanial model which takes into account he wave-particle duality of matter. The authors have succeeded in desribing the same from basic principles, but Compton effect needed more elaborate treatment. In Schroedinger's wave equation (sec. 7), wave function ψ is confused with ψ . The authors have utilized both these functions for describing time-independent wave function, whereas the latter is generally taken to denote the total wave function including time-dependent part. Chapter 3 deals with the arrangement of electrons and their energy levels in atoms. Certain terms (e.g., degeneracy and selection rules) are not explained when used for the first time.

Chapter 4 deals with the Schroedinger's wave equation. A few applications of this equation, e.g., particle in one and three-dimensional boxes and hydrogen atom, have been treated well. In this chapter, rules of quantum mechanics should have also been included.

Second part of the book describes the periodic classification of elements and periodicity in atomic properties. The historical development of Periodic Table from Proust (1815) to present is described very the lucidly. The authors elucidate the electronic configurations of all atoms, and the classification of ions on basis of their electronic configurations. A chart given depicting the ground state electronic configurations of all the 105 known elements. Slater's rules for calculating effective nuclear charge have also been given. The authors have discussed all the atomic properties, especially the physical properties thoroughly. Ideas on ionization potentials, electron affinity and electronegativity have adequately dealt with.

Each chapter of the book is enriched with appropriate figures and tables. At the end of each chapter, objective type questions with answers, unsolved questions and references have been included. It is a pity that there are many printing mistakes in the book. In certain cases, repetition of subject-matter not desirable. The monograph otherwise, is a good attempt to mente the demands of students of B. S. (Hons.) and M.Sc. in chemistry of various Indian universities.

H.O. GUPT Dept. of Materials Science Indian Institute of Technolog Kanpi

ELECTRICITY AND ELECTRONICS by S.L. Kakani, H.B. Saxens U.L. Chhajed and M.S. Lodher The Students Book Co., Jaipur Pp. 348, Rs. 13.75.

ELECTRONICS, the branch of science and technology which is concerned with the study of the phenomenon of conduction of electricity in vacuum, in gas, and in semiconductors, and with the application of devices which use these phenomena, has expanded so wide that it has made room for itself in every discipline of science. Electricity and electronics are the back bone of the present day technological development.

The authors have rightly divided the subject matter into two sections In the section on electricity, the au thors present brief reviews of ballis tic galvanometers, transient currents alternating current circuits and cir cuit analysis. This section start with the introduction of galvano meter, and describes various method to measure electrical quantities by the use of galvanometers with necessary description. The transien currents produced by sudden open ing and closing of various simpl electrical circuits having d.c now the current changes in time has been carefully examined, and the properties of resistance, inducance and capacitance subjected to ransient currents have been explained. The simple circuits consisting of resistance, inductance and capacitance, inductance and capacitance, and the analysis of networks have also been described.

The electronics section is mainly based on electron emission, thermionic vacuum tubes, conduction in emiconductors, semiconductor derices, rectifiers, vacuum tube ampliiers, transistor amplifiers and vauum tube oscillators. The princiieles of thermionic vacuum tubes, ectifiers and vacuum tube ampliiers have been discussed in detail.

A brief review of all types of tube

amplifiers has been given in Chapter 6, in which the diagram sizes are so reduced that it is difficult to understand them. Similar is the case in the chapter on transistor amplifier.

In such a small volume the authors have touched upon a large number of topics. A significant feature is that many of the problems presented at the end of the chapters involve numerical calculations which are indeed helpful to clarify the theories described. To create confidence in students, some problems have also been solved. The book is useful to B.Sc. (pass course) students.

As a matter of fact, the title is misleading as the book does not cover sufficient literature on electricity and electronics for even graduate students as claimed by the authors. The prime objective of the authors to write this book, in the opinion of this reviewer, seems to introduce electronics to the reader, because is difficult to write an up-to-day comprehensive book on such a wide subject as electronics. Though the authors have introduced the subject well, they have not kept their promise to base their book "on new syllabut for degree and postgraduate students of Indian universities" a mentioned on the first page.

VUENDER SHARM

Microwave Laborator
Department of Physics an
Astrophysic
University of Delhi-

MELTING BY LEVITATION (Continued from page 420)

entre. The situation in Fig. 4a s also stable with respect to horiontal displacement.

pplication

In the actual application levitaion can be carried out in air, vacuum
ir in inert atmosphere. The
holten levitated mass can be remoed into a suitable receptacle or
imply dropped as a whole by merely
djusting the current in the coils.
In general, iron base alloys are most
eadily levitated and melted. Other
examples include A1, Cu, Ni, Ti, Zr,
lb, Ta, etc., and various alloys of
hese metals. It is difficult to melt
ome metals, with a high melting
oint, like tungsten (m.p. 3370°C).

Such metals can, however, be melted using supplementary heating sources.

During melting under inert atmosphere or vacuum, the volatile impurities are easily eliminated from the suspended mass. Levitation melting then becomes an aid in refining. In the laboratory, the arrangement is used for direct observation on reactions of various gases with liquid droplets. Such studies are extremely useful in better understanding of many industrial phenomena. Small, clean castings may be produced by dropping the levitated mass into a metallic mold. If the mold is cold then there would be rapid quenching. Sometimes this may result in improved properties of the metal.

Further reading

- Comenetz, G, Brace, P.H. and Kelley, J.C.R., Electromagnetic Levitation of Solid and Molter Metals, J. App. Physics, Vol. 23, May 1952, pp 545-552.
- Simon, I., Little, Arthur D. Forces Acting on Sphere Conductors in Magnetic Fields, J. App. Physics, Vol. 24, No. 1 Jan. 1953, pp. 19-24.
- Booth, A.R., Charles, J.A., Levi tation Melting Apparatus for Phase Equilbria Studies, Nature Nov. 12, 1966, pp. 750-751.

Much nicer in colour



PRICE OF CA74ICT OP. AMP. REDUCED TO RS. 15/- (from Rs. 25/-)



Applications:

- Comparator
- DC amplifier
- Integrator or differentiator
 Multivibrator
- Narrow band or bang-pass filter
- Summing amplifier

Features:

- Short circuit protection
- Internal frequency compensation
- High open loop gain
- Low input bias current
- Low input offset current
- **Balanced** input
- Operating temperature range 0° to 70°C
- Available in 8 lead To 5 package

Maximum Ratings, Absolute - Maximum Values at T, = 25°C

DC supply voltage

(Between V + and V - terminals)

Differential input voltage

: + 30 V

DC input voltage *

Output short-circuit duration

Device dissipation upto 70°C

: 500 mW

* If supply voltage is less than + 15 volts the maximum

input voltage is equal to the supply voltage.

For further details, write to: Components Sales Division



(A Govt. of India Enterprise) Jalahalli, Bangalore 560 013

Also available at our Sales Depots:

4th Floor, "Sukh - Sagar", S. Patkar Road, BOMBAY 400 007, Phone: 359347 2/12, Ansari Road,

NEW DELHI 110 002, Phone: 275142



CMBEL-7610



RETINAL DETACHMENT CAN CAUSE BLINDNESS



Re. 1.00

COUNCIL OF SCIENTIFIC & INDUSTRIAL RESEARCH NEW DELHI-110001

A LOOK INTO THE IONOSPHERE

SEA SEDIMENTS TELL OF EARTH'S PAST

HOW ARE CLANDESTINE TVs DETECTED?

SOME UNIQUE FROGS AND SNAKES OF INDIA

HOW MUCH PESTICIDES IN OUR FOOD?

NATION REGAINS SPIRIT OF ADVENTURE 1975-76

New life in villages

- Over six and half million house sites allotted;
 368,000 of them developed, Construction of
 246,000 houses completed.
- Bonded labourers numbering about 47,000 freed.
- Land ceiling laws yield 1,667,000 acres of surplus land, out of which 424,000 acres have been allotted so far. Beneficiaries number nearly 180,000.
- Nineteen Rural Banks set up; 50 more planned during 1976-77. Co-operative credit institutions strengthened.

NATION REGAINS SPIRIT OF ADVENTURE 1975-76

Progress in Power Output

- All-time high of 79,764 million units generated.
 Record output of 260 million units per day.
- 25 new power units generated 1800 MW, 20 of them between September 1975 and March 1976.
- 2,050,000 hectares of additional, irrigation potential expected to be created this year.
- 6,356 villages electrified, taking the total to 174,079,140,000 pump sets energised.

davp 76/89

to our contributors

- SCIENCE REPORTER welcomes articles of absorbing interest on science and technology. Contributions
 published in the Journal will be paid for.
- Articles should be sent to the Editor, SCIENCE REPORTER, CSIR, Rafi Marg, New Delhi-110001.
- The form and manner of presentation of the subject should be easily understandable to the undergraduate level.
- The length of the article, written exclusively for the Journal, may be about 2500 words.
- The matter should be typewritten, double space on one side of the paper; the original and a carbon copy are to be sent.
- The article should preferably be illustrated; captions and legends typed separately and attached at the end of the article. Photographs should be on glossy paper.
- While quoting names of scientists, etc., their initials, nationalities and periods of research under reference should invariably be mentioned. All weights and measures should be given in Metric Units.
- A short note about the contributor should also accompany the article. The note should contain age, academic accomplishments, important assignments held, fields of research and hobbies.
- Articles or illustrations published in the Journal can be reproduced with permission of the Editor.
- The Editor reserves the right to reject even invited articles without assigning any reason.

SUBSCRIPTION	То					
FORM	The Editor SCIENCE REPORTER					
	C.S.I.R., New Delhi-110001					
	Please enter/renew my subscription to SCIENCE REPORTER for one year. I am sending Rs. 10.00 by M.O/P.O.					
	No dated marked payable to CHIEF (ADMN.), CSIR, NEW DELHI-110001.					
	Name					
	Full Address					
	(in capitals)					
	PIN					
	(Old Subscription No) Signature NOTE: Please mention old Subscription No. in M.O. compon also					



NO. 8

SCIENCE REPORTER

452 LETTERS

454 PLANETS AND THEIR POSITIONS—SEPTEMBER 1976

MAIN ARTICLES

455 Deep sea sediments reveal secrets of earth's past S. Krishnaswami

462 A glimpse of ionosphere D.K. Gangopadhyay

467 Prospects of somatic hybridisation in plants S. C. Ray

471 The stars that pulsate Dilip M. Salwi

478 Retinal detachment can cause blindness Bijayananda Patnaik

485 SCIENCE SPECTRUM

Television detector cars—Lymphocytes-the cellular basis of immune response—Improvements in gene isolation techniques—Bionics, the science that copies from nature—Odour communication in man—Bajra cause ergot poisoning—Unique frogs and snakes of India—Gars and gharials

499 NEWS AND NOTES

Dr. M.L. Munjal—an interview

500 MEDICAL NOTES

Caution about breast injections-Pesticides in our foods

503 SCIENCE FOR THE YOUNG

Silk—the queen of fibres—Surprise in sizes— Science wheelword puzzle

508 SCIENCE IN INDUSTRY

Electronic score board-Radome

510 BOOK REVIEWS

India: The Energy Sector-Let's Discover Science

he Council of Scientific & Industrial essench assumes no responsibility or the statements and opinious lyanced by contributors.

ackground: A contrast (Floorescent) otograph of the retina, Inset:

clina being examined with an

direct ophthalmoscope.

cience Reporter is issued monthly.

Annual Subscription

nland : Rs. 10.00

Foreign: \$ 5.00

Editor: S.P. Ambasta Asstt. Editors: C.B. Sharma, Zaka Imam Editorial Staff: Dilip M. Salwi, Nisha Misra Sales & Advt.: G.N. Jaswal, G.E. Salpek Production: V.S. Chaturvedi



Know your environment

Sir, Apart from the air, water and and pollution mentioned by the late Dr. Seth in his Know your environment S.R. Jan., 1976), noise pollution in ndia is no longer uncommon. Noise s not just an irritant but a definite hreat to health. Webster defines oise as "a sound that lacks agreeble music quality or is noticeably oud, harsh or discordent". Noise is f uneven sound waves and gagged appearence if viewed in an osciloscope. Noise is measured in bels after Alexander Graham Bell). A ecibel is 1/10 of a bel. Depending n the quality or pitch of the sound ain is inflicted at about 120 decibels. f one bears a sound of 140 decibels or a few minutes or 150 decibels for few seconds severe pain and tempoary loss of hearing will result. Noise f a jet plane taking off at close roximity is one billion times more tense than the normal level. (It is 40 dB while the background noise 50 dB only).

Workers in a very noisy factory re liable to lose an average of 50 ecibels of their hearing range by orking for 15 years at 100 decibels oise level. Hence the normal range f 20-25 dB changes to about 70 B. A lawn mower makes 100 dB f noise to the user. Prolonged exponer to high intensity noise results in ass of hearing and even total deafess, ulcers, severe headaches, stonach upset, allergies, asthma, insomia and emotional breakdowns. At a unexpected or unwanted noise the upils of the eye dilate, the skin pales

and the mucous membrane dries up; there are intestinal spasms and the adrenals explode excretions. In a nutshell, biological organism is disturbed. Experiments with rats showed gastric ulcers, thymus gland atrophy and over stimulation of the adrenals. Psychologist Dr. Edward C. Hews reports, "Prolonged subjection to an unpleasant noise or even a pleasant sound which is too loud or which comes at the end of a horrowing day, can lead to severe mental deterioration, and in some cases, violence. Even some people consume alcohol, drugs, tranquillisers and sleeping pills to get out of this hazard".

A.K. KUMARAGURU

Research Scholar,

Centre of Advanced Study in

Marine Biology

Annamalai University

Porto Novo-608502

Communication by satellites

Sir, It has been mentioned (Communication by satellites, S.R. March, 1976) that a satellite at a height about 35,680 km in a circular path over the equator becomes 'stationary' as it synchronises with the rotation of the earth. It has been further mentioned that at this height three uniformly spaced satellites, may be equatorial or inclined, can 'cover' the entire surface of the earth. This statement is correct, however, for stationary satellites in the equatorial plane. If, on the other hand, the orbit is inclined to the equator the point on the earth directly beneath the satellite will not be fixed but trace a figure eight symmetrically about a meridian line, moving north and south of the equator to latitudes equal to the inclination angle.

S.K. GURTU

Defence Sc. Laboratory

Metcalfe House

New Delhi

Mushrooms

Sir, I read the too familiar arg ments of S. Laxman Rao in S.I Feb., 1976. Views expressed by Ra about the use of mushrooms by th poor are totally baseless and mislead ing. Mushrooms sell at Rs. 25/- pe kg in the market. The preparation of 250 gm of mushrooms (markete as Khummi) would cost Rs. 12/ So, in a poor country like India, is meaningless to suggest to the poo people the nutritional value of mush rooms. The mushroom industry ca flourish only in rich Europea countries. Further, the develop ment of mushroom industry is no easy. It is beset with difficultie arising from the presence of parasiti fungi, active insects and weeds lik Verticillium sp., Mycogone perrnicio sa, Dactylium sp., Bacterium tolas and others.

Indians can make good use of mushrooms if they are encouraged to prepare ink (obtained from Coprina comatus—a mushroom) and antibiotics.

> D.A.V. College Kanpu

Antitranspirants

Sir, I read with much interest Antitranspirants reduce the water need in agriculture by M.K. Sadhu (S.R. Nov., 1975). The author says "Except in conditions of high isolation and relatively high humidity plant leaf temperatures are very close to ambient temperature".

The possible effect of the transpirational stream on the uptake and transport of minerals has been much debated in recent years. There appears to be some effect of transpiration rate on ion uptake. I request you to explain it.

NARENDAR K. SHARMA Malhotrian Street Old Hospital Road Jammi Sir, Thanks for the informative and interesting article Antitranspiants reduce the water need in agrialture (S.R., Nov., 1975). I would be to know the role of antitranspiants in improving sugar content and mechanical strength of plants.

M.J. KHAN
Deptt. of Botany
Govt. P.G. College
Mandsaur

ranspiration and leaf temperature. leaders should read insolation in lace of isolation.

The energy input to a particular lant or leaf comes from direct solar adiation. A small amount of this nergy is used in photosynthesis and still smaller quantity of heat can be tored in the leaf, but most of the nergy load of leaves is dissipated y three mechanisms: reradiation, onvection of sensible heat and latent eat transfer by transpiration. Detail tudies of the energy exchange of arious types of leaves have been onducted by several workers and the eader may refer to the following eferences for further details. In this onnection, I would like to emphasize hat leaf temperature is not fixed, ut rises and falls as a result of contiuous interaction between several nvironmental factors.

teferences

- Cook, G.D., Dixon J.R. and Leopold. A.C. (1964), Transpiration: Its effect on plant leaf temperature, Science, 144: 546-547.
- Gates, D.M. (1968), Transpiration and leaf temperature, Ann. Rev. Plant Physiol. 19, 221-238.
- Raschke, K. (1960), Heat transfer between the plant and the environment, Ann. Rev. Plant Physiol., 11: 111-126.
- Lemon, E.R. (1963), Energy and water balance of plant commu-

nities in L.T. Evans (Ed.), Environmental control of Plant Growth, pp. 55-78, Academic Press Inc., New York.

Transpiration and ion uptake. D.R. Hoagland and his associates (1944) found that transpiration has no direct effect on salt absorption. They concluded that any increase in salt uptake accompanying increased transpiration is an indirect effect in which more rapid removal of salt from the xylem in the roots causes more rapid active transport into the xylem. This view was generally accepted until 1953, when B. Hylmo on the basis of his experimental results reopened the question by indicating that transpiration directly affects salt uptake. It is difficult to review the voluminous literature which appeared since then and the reader may refer to the following reviews for details. There is no doubt that in many instances increased water uptake due to rapid transpirational water loss is accompanied by increased absorption and translocation of salts to the shoot. However, it remains uncertain whether tanspiration causes the increase directly by increasing mass flow of ions into roots in the transpiration stream, or indirectly by stimulating active transport into the stele or both. Nevertheless, on the basis of reports obtained so far following generalizations can be made:

- (i) Under conditions of limiting minerals in the soil (1 mM or less), wide ranges in transpiration rate make little difference in the uptake of minerals, but when soil minerals are abundant, uptake may be related to the rate of transpiration.
- (ii) In case of ions absorbed actively, especially those that are quickly metabolised (e.g., NO, NH,) the

effect of transpiration is slight event at high concentrations (80 mM).

(iii) In case of some plants (e.g maize, beans) the effect of transpiration seems to be slight ever at relatively high concentrations but in other plants it appears the significant.

References

- Brouwer, R. (1965), Ion absorption and transport in plants Ann. Rev. Plant Physiol., 16 241-266.
- Russel, R.S. and Barber, D.A. (1960), The relationship between salt uptake and the absorption of water by intact plants, Ann. Rev. Plant Physiol., 11: 127-140

M.K. SADHI

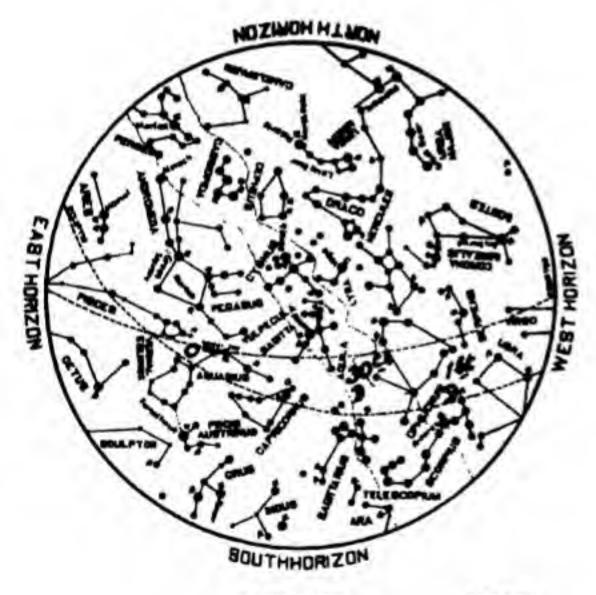
H

Various materials have been tried to reduce transpirational water los and diverse results have been reported on the effect of antitranspirants or different physiological processes However, reports accumulated so far indicate that antitranspirants in general, reduce photosynthesis causing reduced carbohydrate leve in the plant. Plastic film forming type antitranspirants are reported to increase the mechanical strength of plant as is evident from a lowe incidence of certain fungus disease and insect infestations, even when the antitranspirant is nontoxic to pathogens. Growth retardants, which have also been tried as antitrans pirants, are reported to increase mechanical strength of cereals reducing lodging in heavy rain and wind.

> M.K. SADHU College of Agriculture Univ. of Calcutte Calcutte

Planets and their positions

SEPTEMBER 1976



The moon

FULL moon occurs on 8th at 6-22 p.m. and new moon on 24th at 1-25 a.m. I.S.T. Them oon passes about a degree south of Jupiter in the night of 14th, six degrees south of Saturn on 20th and about half a degree

south of Venus on 25th. The lunar crescent becomes first visible after the new moon day in the evening of 25th. The moon is at apogee or farthest from the earth on 13th and at perigee or nearest to it on 25th.

The sun is at the autumnal equinox on 23rd.

The planets

Mercury (Budha), an evening states about an hour after sunset during the first quarter of the month. Thereafter it is too near the sun to be visible being in inferior conjunction on 22nd. Towards the close of the month it reappears as a morning state and rises about an hour before sunrise. It passes about for degrees south of Mars on 1st, fix degrees south of Venus on 6th and becomes retrograde on the 9th It moves from Virgo (Kanya) to Le (Simha) by retrograde motion. It visual magnitude is about +1.0.

Venus (Sukra), an evening stated sets about an hour after sunset during the month. It passes about half degree north of Mars on 11th an about three degrees north of the stated Spica (Chitra) on 20th. It moves from Virgo (Kanya) to Libra (Tula Its visual magnitude is about -3.3.

Mars (Mangala), visible in the evening sky, sets about an hou after sunset during the first three quarters of the month, after which it is too near the sun to be visible It moves from Virgo (Kanya) to Libra (Tula). Its visual magnitude is about +1.9

Jupiter (Brihaspati) rises about two hours before local midnight during the first half of the month and about three hours before it during the second half. It becomes retrograd on 20th. It is in Taurus (Vrisha) Its visual magnitude is about -2.2

Saturn (Sani), visible in the morning sky, rises about three hours after local midnight during the first half of the month and about two hour after it during the second half. It is in Cancer (Karkata). Its visual magnitude is about +0.6.

(Source: Nautical Almanac Unit of the Meteorological office, Alipore Calcutta-27).

The dating methods introdu the parameter of time in the study of deep sea sediment It enables us to reconstru earth's past in a chronologic order

TATURE has been writing Autobiography since its birt Its pages, for the past several million of years, are the layers of sedimen buried under the oceans and the roc over the continents. The continent records are incomplete and illegib due to destruction of evidences b erosion, but those in the deep se sediments are intact giving a cont nuous record of earth's past. Th unique nature of deep sea sediment has stirred a good deal of interes among geochemists who are tryin to use these deposits as a tool t reconstruct the earth's ancient his tory. Several techniques have bee developed to decipher the message contained in the sediments. One of them is 'radiometric dating.' Thes dating methods introduce the para meter 'time' in these studies which allows the reconstruction of earth' past in a chronological order. Her we will discuss the principles an applications of these methods.

Deep sea sediments are formed b particle-by-particle settling of mate rials introduced into the oceans



hese particles consist of minerals rought from the continents by rivers nd wind, flakes of volcanic ash. keletal remains of countless marine rganisms and cosmic materials illing from outer space. Since parties are settling one over the other, ne material deposited yesterday will e covered by new particles of today nd today's deposit will be covered y materials of tomorrow, and so on. downward sequence in the sedient is therefore a sequence back Since these sedimentary time. equences extend over the past several nillions of years, they contain clues many fundamental questions rearding earth's past history. To a eologist the sediments tell the story f volcanic eruptions, formation and etreat of ice sheets, climatic changes, tc.; to a biologist they provide nformation on the evolution of life nd the emergence of man; to an strophysicist they give clues to the me variations in the input of cosmic naterials on the surface of earth. To nderstand all these global events seuentially, it is essential to introduce he parameter 'time' in these studies, e., to 'date' the deposits. Science of ating the past is known as 'geohronology'. To study ancient worldvide events we need to, (i) collect indisturbed columns of sediment, cores', and (ii) date them using uitable techniques.

Cores for studying earth's past are ollected generally from the open cean regions, i.e., far away from the continents. This is because a core collected from the open ocean region vould cover a much larger time span ompared to a core of equal length aised near the coast, since the amount of material depositing per unit of ime in open ocean areas is much less ompared to that in near coastal nvironment. The cores are collectd by allowing simple tubes (corers) penetrate into the sediment either y gravity (gravity coring) or using a iston (piston coring) and carefully auling them back to the ship.

Though it reads simple, collection of undisturbed cores is a tedious and time consuming task. Using a gravity coring device it is possible to get about 3-5 m long cores, compared to piston cores which can be as long as about 50 metres. During the last decade, through considerable advances in coring technology (Deep Sea Drilling Project, DSDP), it has become possible to obtain cores as long as 1000 m.

Geochronological methods

Geochronological methods can be broadly classified into two categories: (i) stratigraphic; and (ii) radiometric. Stratigraphic methods are based on the study of "strata" or layers present in sediments. The stratigraphic method of dating can be better understood through the following analogy. Let us assume that, one day in the past, our ancestors threw a number of red pebbles over a large area of the ocean. Today when we collect cores from different regions of the ocean, we might find a layer of red pebbles occurring at different depths in them, i.e., in one core the pebble layer may occur at 10 cm from its top surface, in another it may be present at 100 cm from top. The depth at which the pebble layer occurs will depend upon the amount of material deposited after the substrate layer has been formed. However, the time elapsed since the formation of pebble layer (i.e., the age) would be the same, as all of them were thrown into the sea on the same day. This age is independent of the depth at which the layers occur. Though this method of dating seems simple, it is applicable only if we know the day on which the pebbles were thrown into the sea. It means that, for using the stratigraphic methods for chronology, it is essential to know the time of formation (age) of the layer. Once a core containing such a marker has been dated, the level in all other cores where that particular marker has been found can be assigned the same age.

In deep sea sediments 'red pebble are not found but we can recognize different layers using other types of markers, e.g., (i) variations in colou (due to the deposition of differen types of sediment); (ii) faunal change (caused by the variations in the rela tive abundances of marine orga nisms); and (iii) changes in the may netic direction of sediment particle (caused by the reversals in the earth' magnetic field). Now the problem i to ascertain the ages of these differen markers present in sediments. Thi is achieved through radioactive da ting techniques. Before we go into th details of radioactive dating, let u first briefly discuss the process of radioactivity.

Radioactivity and radionuclides

The atoms of several elements that occur in nature have unstable nuclei transform of decay to more stable states by givin out different types of emanation. This process of transformation is called "radioactivity" and the elements that undergo this process are called "radioactive nuclides" of the called "radioactive nuclides".





"I feel reassured when you say that Il your interests are not in things ast."

radioactive isotopes". The original adioactive atom is called the parent" and the atom formed after ne decay is called the "daughter" .g., 234U decays to 230Th by mitting alpha particle; an ere 234U is the parent and 250Th is ne daughter).

The radioactive decay follows mple laws. The radioactive decay ste of a group of atoms of a radiouclide at any time is proportional to ne number of atoms present at that me. The proportionality constant is known as the 'decay constant'. is a definite and specific property f the nuclide. Its value depends on ne element, and is independent of its hysical state and environmental onditions (e.g., temperature, presare) in which the element is existing. he radioactive decay law can be xpressed as

$$N_{t} = N_{o} a^{-\lambda_{t}} \cdots (1)$$

$$= \frac{1}{\lambda} \ln \frac{N_{o}}{N_{t}} \cdots (2)$$

here N, is the number of radioctive atoms at time I and No is the riginal number of atoms (i.e., at =0). From relation (1) we can define nother useful parameter, the halffe of the radionuclide. Half-life (1) is the time during which the umber of atoms decreases to half of s original value (i.e., when No beomes No/2). For example, if 1000 toms of a radionuclide decay to 00 in an hour its half-life is one hour. t the end of second hour half of

500 (i.e., 250) atoms will survive, and at the end of the third hour there still will be 125 atoms of the original nuclide. Thus it will take a very long time to decay all the atoms of the radionuclide. This type of depletion process (Fig. 1) is known as the 'exponential decay'.

Every radioactive parent atom produces a daughter atom, which can either be stable or radioactive. If it is stable, then its number of atoms increases with time. If the daughter is radioactive, there is competition between its production and decay. In time, it attains a equilibrium value governed by the half-lives of the parent and daughte nuclides. A measure of the growth of the daughter nuclide will also be time indicator. It is this characteris tic property of radioactivity-eithe the decrease of the parent concentra tion or the systematic increase of th daughter in time-that makes it useful geological clock.

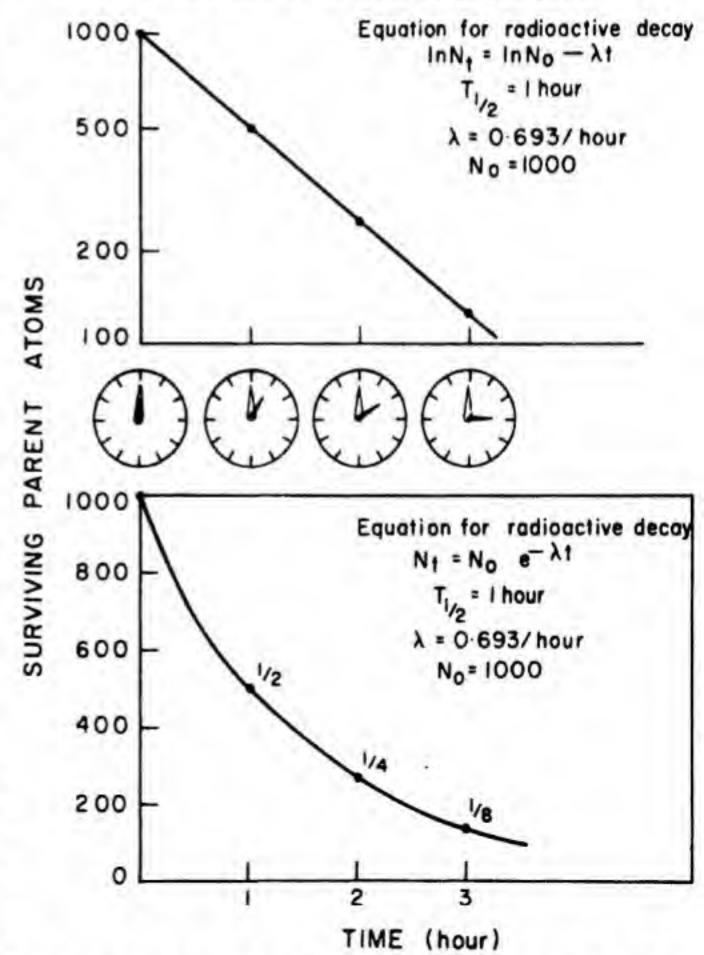


Fig. 1. Radioactive decay follows the 'exponential depletion process'. No is the number of atoms of the radioauctide at the beginning, which decays with a half-life of one hour. The upper graph is a plot of the logarithm of the surviving atoms agains time. (Exponential decay when plotted on semi-logarithmic coordinates gives in straight line)

The radionuclides which are useal for geochronology can be classied into two groups based on their

ode of formation.

hey are produced continuously in ur atmosphere. Cosmic rays coming om outer space encounter atoms of 1, O, or Ar and split some of them roducing several nuclides, e.g., Be, 14C, Si. The half-lives of these nuclides, though relatively short, cour in atmosphere and oceans measurable concentrations because of their continuous production.

Primordial. They are nuclides pro-

Primordial. They are nuclides proluced by burning of hydrogen in the
interior of stars and were incorporatid into our solar system (and hence
into earth) during its formation. Belause of the very long half-life of
these nuclides (billions of years) they
are still present in measurable quanities on the surface of the earth. Such
luclides include potassium-40, rubilium-87, thorium-232, uranium-235
and uranium-238. In addition to
these parent primordial nuclides,
leveral of their radioactive daughter
products are also useful for geochroloological work.

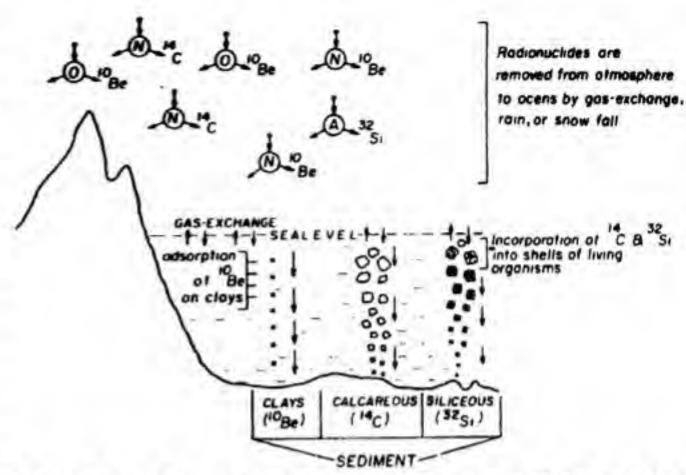
The nuclides which are commonly used for geochronological work are given in Table 1. The application of these isotopes for dating is subject to their satisfying a few conditions.

Some of them are:

(i) The initial concentration of the nuclide (N₂ in equation 1) must be known. Alternatively, if growth of daughter is used for chronology, he initial ratio of number of atoms of the daughter to that of the parent must be known.

(ii) There should be no gain or oss of the parent or daughter nuclides from the system other than by adioactive process. This is called he "closed system" assumption.

Another important factor to be considered is the applicability of the adionuclide for dating the time nterval of interest. This is governed by the half-life of the isotope. In



clg. 2. Over simplified picture of the production of 18Be, 18C and 18SI by cosmic rays in the atmosphere and their transport to deep sea sediments. 18C and 18SI dating methods are applicable to 'calcareous' and 'siliceous' oozes, whereas 18Be method is method to date

general, the upper time limit for which a radionuclide can be used for dating is about 6-7 times its half-life. This is because after 6-7 half-lives, the concentration of the radionuclide would be very low, less than about 2% of its original value and hence would be difficult to measure. For example 16C (T)= 5700 yrs) can be used to date samples which are upto 40,000 years old. However, with high sensitive measuring devices it is possible to extend the upper limit to about 10-12 times the half-lives. On the contrary, if the time span under study is too short compared to the half-life of the isotope, the amount of decay (or the growth of daughter nuclide) would be very small compared to the initial value. Hence to obtain an unambiguous estimate of the age, the lower limit of applicability of any nuclide can be arbitrarily set at about 15% of its half-life. During this time, the decrease in the activity of the nuclide (or growth of the daughter nuclide) would be about 10%, which can be measured precisely. However, it must be mentioned that the usefulness of a particular isotope depends on the

sensitivity of the method used for its measurement.

Use of cosmic ray-produced radionuclides

Three cosmic ray produced isotopes (Table 1) are used for dating deep sea deposits. They are ¹⁴C, ¹⁰Be and ³²Si. Fig. 2 shows an over simplified picture of their production in the atmosphere and transit to deep sea sediments.

¹⁴C is produced by bombardmen of atmospheric nitrogen atoms with cosmic ray neutrons. The ¹⁴C thu produced is quickly oxidised to



"Instead of taking interest only is earth's past had you taken som interest in your own future, our present would have been more pleasent."

U-238 SERIES			200	Th-232 SERIES					U-235 SERIES								
Uranium	U-238		U-234										U-235	3			
Protoactinium		Pa-234											1.00	Pa-23			
Thorium	Th-234		Th-230					Th-232	1	Th-228			Th-23	/	Th-227		
Actinium			à						Ac-226					Ac-227			
Radium			Rg-226					Re-226		Re 224			-		Re-223		
Francium			a		1		1			à				1	a		
Radon			An-222							Rn-220					Rn - 219		
Astatine			a							a					a		
Polonium			Po - 216	1	Po-214		Po-210			Po- 216		Pe-212 3.10			Po - 215		
Bismuth		F	a	197-	4	Bi - 210	a			11.	BI - 212	α	ľ			BI- 211	
Lead			Po-214		PD-210)	Pb-206			Pb- 212	_	P6 208			Pb - 211	a	Pb-207
Thallium											TI-208					T1-207	

g. 3. Decay chain of Uranium-238, Thorium-232 and Uranium-235 nuclides. **Th in ***U and ***Pa in the ***U decay series are commonly used for dating deepsea sediments. The half-lives of the various nuclides are also given.

CO, and gets mixed with the carbon ioxide present in the atmosphere nd the oceans. Since the chemical roperties of 14C and the stable arbon (12C) are identical, when a lant on land removes CO, from the tmosphere by photosynthesis, it Iso receives a proportional share of Cas well. Similarly, the plants and rganisms (shells, corals, foraminiera, etc.) which extract carbon from ea water for making their shells, also eceive proportional share of 14C. The ratio 14C/19C which these organims extract would be the same as that n surface sea water where they live. This ratio is about 1 atom of 14C to 000 billion atoms of 19C. Once hese organisms die, they cease to xtract any more 12C and 14C from ea water. After their death they ink as part of sediment, where their *C content decreases in time ollowing the exponential law.

The fundamental assumption of 14C dating is that the 14C production in the atmosphere has been constant for past several tens of thousands of years and the 14C/13C ratio in surface waters has always been the same as that of today. If these assumptions are valid, the age of the sample can he deduced by comparing its 14C/ 12C ratio with that of the present day sea water or that of living shells and organisms (No in equation 1). The age of a sample gaving a 14C/ 19C ratio half of present day sea water is one half-life of 14C, i.e., 5700 years. Though 14C is one of the most widely used dating methods, it can be used only to date the sediments containing carbonate materials (calcareous oozes).

Two other cosmic ray-produced isotopes which are used for geochronological work are *Si and *Be.

The usefulness of these isotopes was

suggested by D. Lal and B. Peters. Considerable amount of work using these isotopes has been carried out by the scientists of Tata Institute of Fundamental Research, Bombay, and Physical Research Laboratory Ahmedabad. (For an up-to-date review on the applications of cosmic ray-produced nuclides in oceanogra phy, see Lal and Suess, 1968). 38Si is produced by cosmic ray bombard ment of argon atoms present in the atmosphere and is brought to the oceans and land surface by rain. Th 35 so introduced gets quickly mixed with the stable silicon (*Si) presen in surface waters, analogous t 14C. Organisms which use silica for their shells (diatoms, radiolaria, etc. extract both 28Si and 39Si in the sam ratio as they are present in sea water After the death of the organism they sink to sediments, where ** starts decaying. The estimatio of ages and the assumptions of the Si method are the same as that for C. The greatest advantage of this method is that it is applicable to date deposits which are upto about 1500 years old—a time span difficult to cover by other dating methods. However, this method is useful only to sediments rich in biogenic silica (siliceous oozes).

10Be produced by the fragmentation of atmospheric O.-N. and C atoms by cosmic rays is introduced nto the oceans by rains. Once berylium enters the ocean, it gets quickly adsorbed on settling particles and is removed from the ocean water to ediments. In the sediments 10 Be indergoes radioactive decay. So if we collect a deep sea sediment core ind analyse its 10Be concentration it various depths in the core, it would decrease exponentially prorided, (i) the rate of 10Be deposition on the ocean floor has remained consant over the dating interval, i.e., ast several millions of years, and ii) there has been no physical disurbance of the core. If these condiions are satisfied, a plot of 18Be oncentration versus depth in core hould give a curve as in Fig. 1. fere the value of No is taken to be he same as the 10Be concentration n the surface of the core, the most ecent deposit.

ears. Because of its long half-life his isotope can be used to date amples as old as about 5-6 million ears, a time gap not covered by the rimordial nuclides.

ise of primordial nuclides

Uranium series dating. This mehod involves uranium and two of its
aughter products 200Th and 201Pa
Fig. 3). The transformation of
the U to 200Pb goes through many
tages; an interesting step is the
ause at 200Th. Similarly, when
the U decays to 200Pb it goes through

dissolved uranium in sea water, get adsorbed on particles and are removed from sea water to sediments quickly. This separation between the parent uranium and daughters, see Th and salpa is the basis of the salpa and salpa dating techniques.

The stoTh and salPa deposited on the sediment start decaying after their burial. The age of the sediments can be estimated from the rate of disappearance of soTh and Pa. The two conditions which must be satisfied for successful application of this technique are: (i) the rate of precipitation of moTh and 321 Pa on the sea floor must be constant over the dating interval, and (ii) the rate of sedimentation must be constant over the dating interval. i.e., about 400,000 years for anoth and about 200,000 years for sal Pa. When these conditions are fulfilled, a plot of the logarithm of shoTh or Pa concentration in the sediment as a function of depth in the core would give a straight line. Analogous to 10 Be, the value of No. is taken to be same as the concentration in the surface sediment. Fig. 4 shows a plot of so Th concentration as a function of depth in the core. The straight line indicates that both the assumptions are reasonably valid. Departures from straight line have been observed, which in majority of the cases have been attributed to variations in sedimentation-rate with time.

Of all the dating methods so The is most commonly used, as it is applicable to all types of sediment and is easy to measure. Additionally, since so The concentrations in sediments are generally high, the sample requirements for these measurements are small.

primordial nuclide incorporated into our solar system during its formation. *K decays into two stable nuclides, *Ca and *Ar, by two modes. On an average about 10% of *K (i.e., about 10 out of

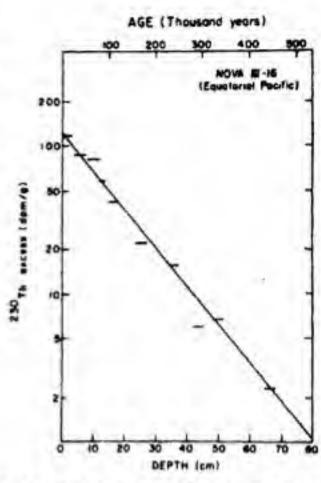


Fig. 4. Plot of the logarithm of ***Th activity
Vs depth in a core collected from
Pacific Ocean. The calculated ages
for different depths in the core are
also given at top. The sedimentation
rate of this core is 1.6 mm/10*yrs

100 oK atoms) decays to the noble gas "Ar, the rest 90% transforms into Ca. For geochronological purposes it is the growth of *Ar which is of interest. This is because when minerals are formed by crystallisation from hot lava, they exclude gases and hence at the time of formation the crystals are free of "Ar, i.e., the "K-"Ar clock is reset during crystallisation. In time, *K decays to "Kr which is stored in the crystals of the rock. Thus the "Ar/ K ratio of the sample is a measure of its age since its crystallisation. ⁶⁰K-⁶⁰Ar technique is useful for age determination of samples older than about 100,000 years. However, its application to deep sea sediments is restricted since the abundance of volcanic ash layers in cores is small. In spite of this, "K-"Ar technique has proved extremely useful for studying the chronology of magnetic reversals.

So far we have discussed the common methods employed for dating deep sea sediments. These methods also provide quantitative information on the rate of sedimentation of naterials on the ocean floor. The age t in equation (1) is the time elapsed since the deposition of a particular sediment layer. If the rate of sedimentation, S (cm/yr) has remained constant, the time t elapsed since the burial of a sediment layer at a depth x cm from the surface of the core is $\frac{X}{S}$ years. Substituting

$$=\frac{X}{S}$$
 in relation (1), we get

$$N_1 = N_0 e^{\lambda \left(\frac{X}{S}\right)} \qquad \dots (3)$$

$$\ln N_i = \ln N_0 - \lambda \left(\frac{X}{S}\right) \dots (4)$$

equation (4) predicts that a plot of he logarithm of activity against lepth in the core would give a traight line with a slope (λ/S) . Cnowing \(\lambda\), it is possible to calulate the sedimentation rate in the ore. Fig. 4 is a plot of this type. The sedimentation rate in open cean regions centres around 1-5 nm/10^a yrs or a few atomic layers per lay. Thus a 10 cm long core from hese regions would correspond to a ime span of about 10,000 years. In ontrast, the rate of sedimentation car coastal regions would be bout a few cm year. It shows that naterials accumulate about 10,000 imes faster in near coastal regions ompared to open ocean areas.

Considerable amount of informaion on the sedimentation rates and ages of sediment layers exists for the Pacific and Atlantic ocean sediments. The available data on the indian ocean and its adjacent seas a sparse. Of these, the Bay of Bengal is particularly interesting, since about 15% of the total solids intro-

Table 1. Nuclear methods for dating deep-sea sediments

Method	Half-life (14) (yrs)	Source	Range of applicability (yrs)		
"C	5.7×10*	Cosmic ray interaction	10° 4×10		
Si	5×10	Cosmic ray interaction	5 × 10°Q2 10		
10Be	1.5×10°	Cosmic ray interaction	0 5 × 10* 10		
Th	7.52×10*	IMU decay	2 - 104 3 - 10		
mi Pa	3.43×104	***U decay	101 1.5 -10		
4K-#Ar	1.3 × 10*	Primordial	10, 10,		

duced by the rivers into the world oceans falls into it. Attempts are now underway at Physical Research Laboratory, Ahmedabad, to study the chemical composition and accumulation rates of sediments in Bay of Bengal with a view to understand their past history and the messages contained in them regarding the past climates.

Volumes of information about the earth's past are being deciphered by studying deep sea sediments. Perhaps the most important of these is the 'Pleistocene" record (Pleistocene is Greek word meaning, 'most recent'). With the help of deep sea sediment, it has become possible to get a complete record of the Pleistocene-the epoch which brought forth the ice age and the man. Scientists are now looking with great interest at the huge reservoir of data available in the sea floor sediments to understand the cause and effect of climatic changes. With the availability of Deep Sca Drilling Cores, which probe back in time as far as about 200 million years, scientists are finding evidence for several climatic changes during the last 100 million years. Another important problem which has attracted considerable attention is the earth's magnetic field reversils, which

are also being studied using deep se sediments. Evidences for extinction of several species of actual corpanism during reversals have been found to deep sea sediment. In addition there are several other interesting problems to which the answers can be found in the sediments. Deep seased ments are therefore much more than mere mud. They tell us about the events occurred long ago and act as a guideline to future events.

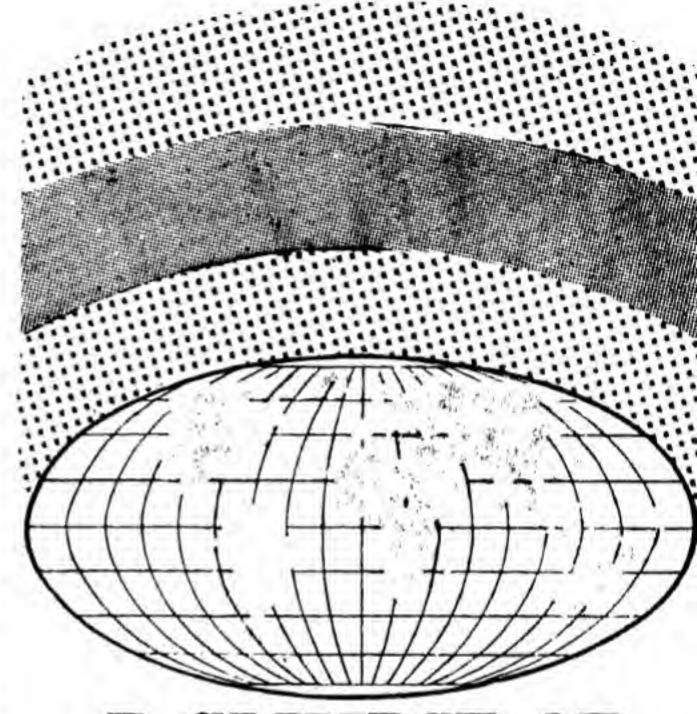
Further reading

- Ericson, D.B. and Wollin, G. The Deep and the Past, Alfred A Knopf Inc., New York, (1964)
- Broecker, W.S., Chemical Oceanography, Harcourt Brac Jovanovich Inc., (1974).
- Goldberg, E.D. and Bruland, K. Radioactive Geochronologies in The Sea, (Ed.) E.D. Goldberg Wiley Interscience, 5, (1974) 451-489.
- Lal, D., Cosmic ray produced radionuclides in the sea, Jour Oceanographic Society of Japan 20, (1962), 600-614.
- Lal, D. and Suess, H.E., The radioactivity of the atmospher and hydrosphere, Annual Review of Nuclear Science. 18, (1968) 407-434.

Ionosphere is solely responsible for short wave global communication. By its study, the frequencies suitable for regular and reliable long distance shortwave radio communication are determined

A T the turn of the present century, on December 12, 1901, G. Marconi demonstrated through his newly invented wireless equipment that radio waves could travel across the Atlantic. But it was a problem for scientists to explain how radio waves could travel such a great distance, as this could not be explained with radio waves travelling in straight lines over the spherical earth. So some conducting layer in the upper atmosphere, it was thought. reflects the waves just like a mirror reflects light. The existence of such a layer was first predicted independently in 1902 by O. Heaviside in England and A.E. Kennelly in the United States. It was then known as Heaviside-Kennelly layer. Later, he name 'ionosphere' was suggested by Watson Watt (British), the nventor of radar. The first direct evidence of the existence of ionosthere was shown by E.V. Appleton and M.A.F. Barnett in England in 925. When the frequency of a listant transmitter was altered by a nown amount, they observed hat the radio waves formed maxima nd minima due to the interference f waves reflected from the ground nd the ionosphere.

Ionosphere is now defined as that eart of the upper atmosphere which ontains ions and electrons in quantiies sufficient to affect the propaga-



A GLIMPSE OF IONOSPHERE

D.K. GANGOPADHYA'

tion of radio waves through it. It usually extends from 50 km to 500 km above the earth's surface. When a radio wave below a certain frequency (30 MHz) is incident on the ionosphere, it is reflected back to the earth and can be received by radio receivers. Without this layer, the wave travelling in a straight line cannot return to the earth and, consequently, reception is not possible. It is the ionosphere that is solely responsible for short wave global communication. From the communication viewpoint, a thorough know-

ledge of the ionosphere is essential to predict the frequencies suitable for regular and reliable long distant shortwave radio communication.

Origin of the ionosphere

The ionosphere owes its originally to the sun, more specifically to the ultraviolet rays it radiate. In the ionospheric region, when air is thin, different gases exist is atomic state. When ultraviole rays from the sun hit atoms, electrons are displaced off their orbit to produce positive ions, i.e., pos-

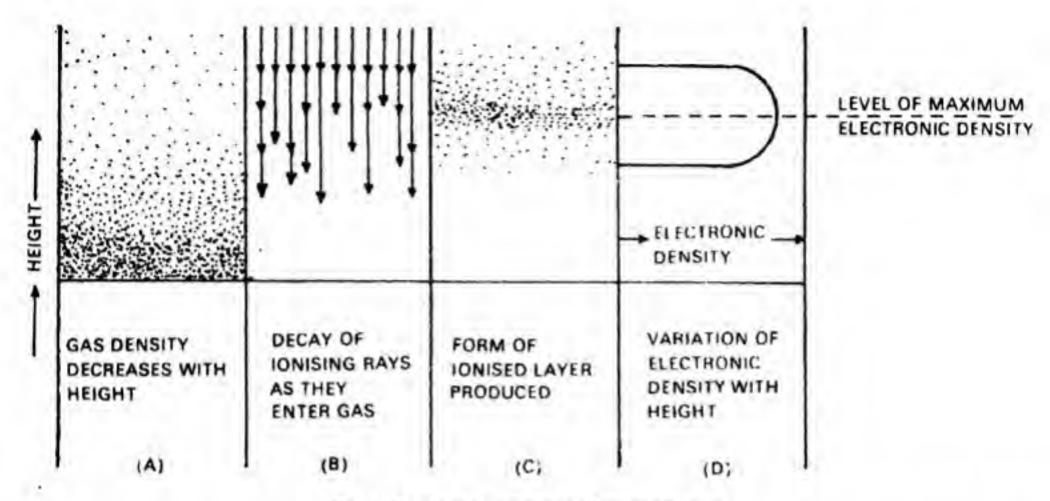


Fig. 1. Details of the formation of an ionised layer

ively charged atoms, and electrons. he electrons being more lighter and nobile may combine with other ons or attach themselves to other eutral atoms or ions. As the energy fultraviolet rays reduces while comng down to the earth and the num er of atoms decreases with altitude. certain part of the atmosphere is nore prone to the production of maxinum ions and electrons creating he ionospheric layers (Fig. 1). lesides ultraviolet rays, corpuscular adiations and X-rays from the sun, neteoric showers and thunderstorms re also responsible for ionisation in he ionosphere. The ionosphere is, herefore, an admixture of neutral ases, ions and electrons and as a hole is electrically neutral. This tate of matter is known as the fourth tate of matter or 'plasma' state. lere the classical gas laws are not alid and a different law is followed. he state is similar to that found side a household tubelight.

xperimental techniques

In 1925, to study the ionosphere

Breit and M.A. Tuve of the United tates designed an equipment called tonospheric Sounder' or Ionosonde.

In this equipment radio waves are sent vertically upwards. The ionosphere reflects them as echoes which are received by the equipment and displayed by measurement. equipment consists basically of a transmitter and a receiver. The transmitter generales a continuous wave of frequencies, from 1 MHz to 20 MHz, pulsed at a regular interval (say, 50 pulses per second). They are radiated vertically upwards by a directive antenna. The reflected wave is collected by a suitable antenna and passed over to the receiver. The receiver further passes over the wave to the display unit, a cathode ray oscilloscope, for study.

The modern version of this equipment is completely automatic and has many advantages. A block diagram of a modern ionosonde is given in Fig. 2. The display of the signals received is photographed and is known as lonogram (Fig. 3). Later, ionograms are studied and scaled to obtain necessary data. The data collected by this method is the principal source of knowledge about the ionosphere.

Most of the present day labo-

ratories in India make use o ionosonde to study ionosphere Rockets are also used. Moreove with the invention of satellite, a nemethod of exploring the ionospher from above, known as topside sour ding, is being used. Much valuable information regarding the ionospher has been collected which otherwis might not have been possible. The Indian satellite Aryabhatta will als help in the study of ionosphere. Th study of ionosphere can also be dor by recording the radio emissions the reach us via the ionosphere from th sun and other stars.

Layers and parameters of ionospher

According to the present day research, the ionosphere is mainly divided into three layers: D, E and F layers. Usually D layer exist between 50 km to 90 km above the earth, E. Layer at 100 km to 12 km, and F layer at 130 km to 45 km. The ionosphere does not enthere. It extends many thousan kilometers beyond the F layer in much rarified space. The ionosphere is rather a continuum in which the above layers represent banks of ion isation without prominent minim

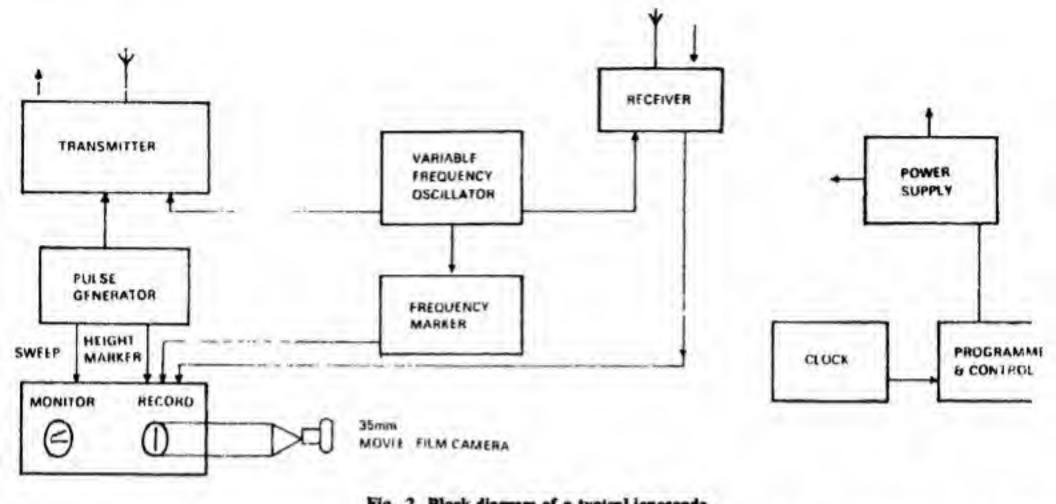


Fig. 2. Block diagram of a typical ionosonde

among them. The F layer is divided into F1 and F2 layers. Sometimes during solar eclipses F, layer s also detected. During night F1 coalesces with F, and D layer vanishes, leaving only E and F layers (Fig. 4). Inside the E layer, there is a random variation of ionisation. This is called sporadic E layer or Es ayer. The exact mechanism of the origin of Es layer is still incomprenensive. It may be due to (i) redisribution of electrons already present, ii) meteoric shower, or (iii) thunierstorms. Because of the random nature of this layer, reliable comnunication is not possible through t. However, communication at requencies much higher than 30 MHz is possible via this layer.

The electron density is highest in he F layer and it is of the order of million electrons per cc. Under nornal condition D layer has the lowest lectron density. The refractive index f ionosphere, the frequency of wave, nd the electron density are related y the equation:

$$n = \left[1 - \frac{81 N}{f^2}\right]^{\frac{1}{2}}$$

there N is the electron density of he layer, n is the refractive index f the layer, f is the frequency f the layer.

As the electron density increases from D to F layer, the refractive index decreases correspondingly. So an electromagnetic wave moving upwards in the ionosphere encounters progressively decreasing refractive indices. It is, therefore, gradually bent and finally starts moving downwards from a point determined by the frequency of the wave and the electron density at that point (Fig. 4).

The important parameters of ionosphere are critical frequency, the height of reflection, skip distance and maximum usable frequency. Critical frequency is the highest frequency which is reflected back by a layer of ionosphere on vertical incidence. At vertical incidence, the angle of incidence is taken as zero. As the angle of incidence is changed, the effect of ionosphere on the wave also changes. When the angle of incidence is quite high, the condi- the maximum usable frequence

tion for reflection (n=sin \, \phi\), \, \phi\ beir angle of incidence is satisfied on with a little penetration of th wave in the ionosphere (ray 1, Fi As the angle of incidence is pre gressively reduced while the frequence kept is constant, the wave returns t a place nearer to the transmitter after penetrating deeper into the iono: phere (ray 2,3). On further reduce tion of the angle of incidence, th wave returns to a greater distance (ray 4). But on further reduction of the angle of incidence, the way will not return at all (ray 5,6). Th minimum distance between the tran mitter and the receiver over which reception is possible by ionospher reflection for a particular frequence is called 'Skip distance' (Fig. 5 Conversely, the particular frequency which will make a particular distance equal to the skip distance is calle



Fig. 3. A typical lonegram

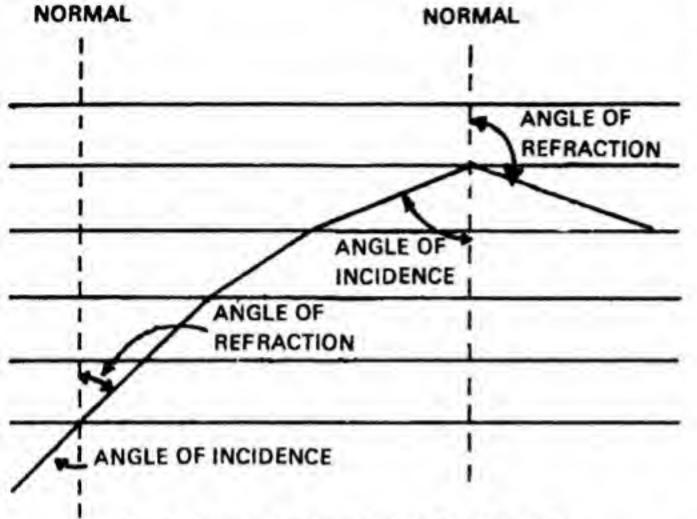


Fig. 4. Reflection of a wave (ray) by the ionosphere

MUF). It is the highest frequency which can be utilised for communitation between two specific points. In practice, a frequency lower (15 er cent) than MUF is used and this known as Optimum Working Frequency. Frequency below it is more boorbed, whereas the possibility of penetration is more above it. I requencies lower than 30 MHz are normally returned. The maximum distance that can be communitated in a single hop by E layer is 1000 km and by F layer 4000 km Fig. 6).

onospheric propagation

Two special aspects of ionospheric ropagation are described here. It observed that the strength of a ignal reflected by the ionosphere aries haphazardly. When these ariations last for a minute or so, is called 'fading'. Fading takes lace when the ionospheric reflectng surface is not smooth. It is due the varying conditions prevalent here. Moreover, the reflecting surace may be regarded as made up f many moving surfaces, each conributing to the signal at a receiver. o the final signal, which is the reultant of all the rays arriving by

different paths (different phases), varies in time to cause fading of the signal.

The other aspect is the 'ionospheric forward scatter'. Although, communication through ionosphere is possible upto a frequency of 30 MHz, however it has been found that at times communication is possible even upto 100 MHz by a process known as ionospheric forward scattering. In this mode the wave is scattered by the irregularities present in E layer, which are caused by meteoric trails or turbulence in the upper atmosphere. But, at present, this process cannot be depended upon for regular communication due to the randomness of the occurrence of scattering. However, radio amateurs happen to contact each other on frequencies much higher than 30 MHz. This sort of communication is not possible by the normal process of reflection from the ionosphere. This can take place only by the process of forward scattering of the wave by the ionosphere.

Ionospheric drifting

The ionosphere is not a calm region. Different motions and tur-

bulences are always present then Regular horizontal movements of ionospheric irregularities have bee observed in all the layers. The average value is of the order of 10 t 100 m per second. The velocity of the movements varies with heigh In the lower layers the irregularitie are caused mostly by wind motion and in F layer they are mostly of elec trical origin. Moreover, there is prevailing drift on which other mo tions are superimposed. The direct tion of motions changes from day t night and with seasons. The driftin is studied by the radio observation of drifting meteor trails, and by fac ing method as well using closel spaced receivers.

Ionospheric variations

As the sun is the main source of ionisation, it is obvious that the con dition of the ionosphere will largel depend on the sun's position an activity. In fact, the parameters of ionosphere have been found to var from hour to hour, from day to day from season to season and from year to year, The long term variation o the ionosphere is caused by what i known as the 11 year sunspot cycle On close observation, black spots ar seen on the surface of the sun which are known as sunspots. The num ber of the spots is a measure of th sun's activity. Ionospheric para meters vary distinctly with the sola activity during the 11 year cycle Variations with the lunar tida effects have also been noted. Th parameters of the ionosphere also vary with latitudes and longitude and with geomagnetic latitudes. A the nature of ionosphere as regard to absorption, occurrence of sporadi E heights of reflections, etc., different at the equator and the poles it reacts in a different manner to wards the same disturbance on th sun.

Ionospheric disturbances

Two different types of ionospheri

abnormal behaviour can be distinguished that are associated with abnormal occurrences on the sun. One is known as sudden ionospheric disturbance or S.I.D. which starts suddenly within two to three minutes and may continue for hours. If the intensity of the disturbance is great, it may completely stop all shortwave communication for that period. This is known as 'fade out'. It is observed only in the sunlight hemisphere. Its rence is attributed to the intense emissions from the sun during solar flares. The fade out is due to the increased absorption of the incident emission in the D layer, the result of an enhanced ionisation in that layer.

The other abnormal behaviour of the ionosphere is called 'ionospheric storm'. It occurs in both the sunlit and dark portions of the earth. It affects both D and F layers. The critical frequency of the F layer is much lowered and so the frequency band is narrowed. Ionospheric storm starts slowly and continues for hours or even days. During this period the intensity of signals received is greatly reduced. This phenomenon, associated with deep and rapid variations of earth's magnetic field, is called magnetic storm. it is caused by the corpuscular radiaion the sun emits during solar flares.

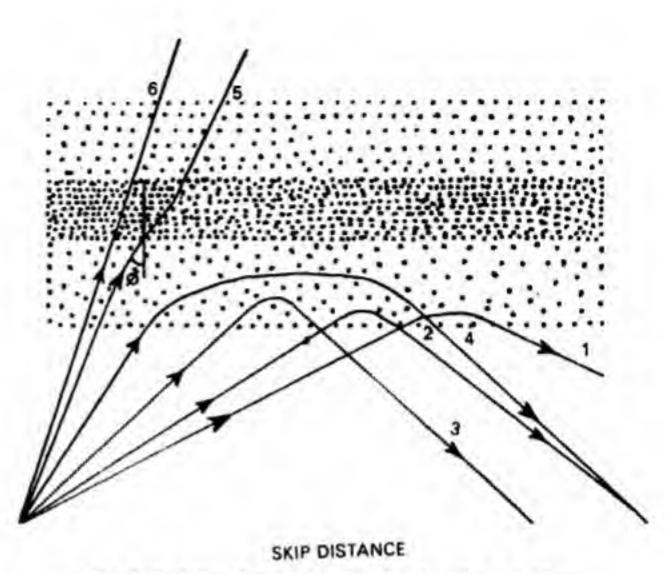


Fig. 5. Variation of ray path with different angles of incidence

A new possibility

In recent times scientists are exploring the feasibility of an altogether new mode of communication through ionosphere. In this mode, a region of the ionosphere will be heated from a ground based transmitter. This will apparently increase the electron density of that region to such an extent that frequencies as high as 300 MHz will be reflected back to the earth. With the help of such communication corridors, greater distances can be covered with much higher frequenci than those in use at present.

Predictions for radio communication

As aforementioned, an exact know ledge of the ionosphere is essenti to predict accurately the frequencie required for clear and reliable lor distance radio communication. Prodictions of various nature are regu larly made by different laboratorie throughout the world. Point-to-poin prediction and area prediction as generally made three months i advance to help the users. Regula prediction series are published b the Department of Interior, Com monwealth of Australia and Depar ment of Commerce, U.S.A. I India, regular prediction charts for point-to-point communication ar published by the Research and Deve lopment Organisation, Ministry of Defence, for the use of the Services Every radio listener must have not ced that the radio stations alter their broadcasting shortwave frequencie with seasons and even with hours o the day. This is mainly done to cope with the ever-changing condi tions of the ionosphere.

The ionosphere is yet to revea (Continued on page 509

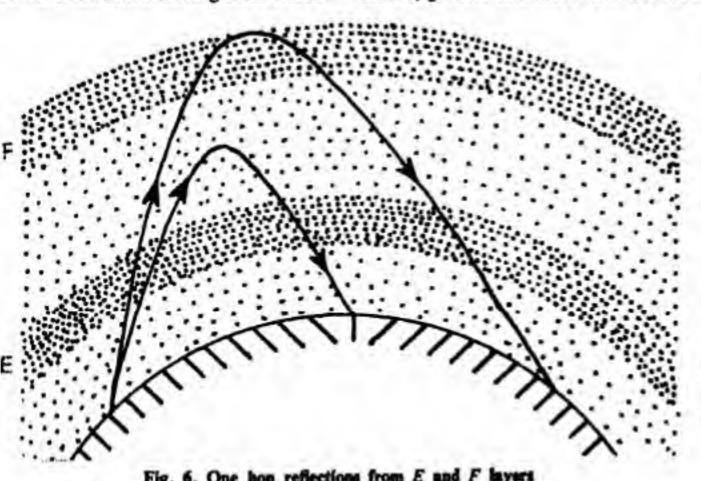


Fig. 6. One hop reflections from E and F layers

Encouraged by the studies on animal cells, scientists are not trying sometic hybridisation of plants

Prospects of somatic hybridisation in plants

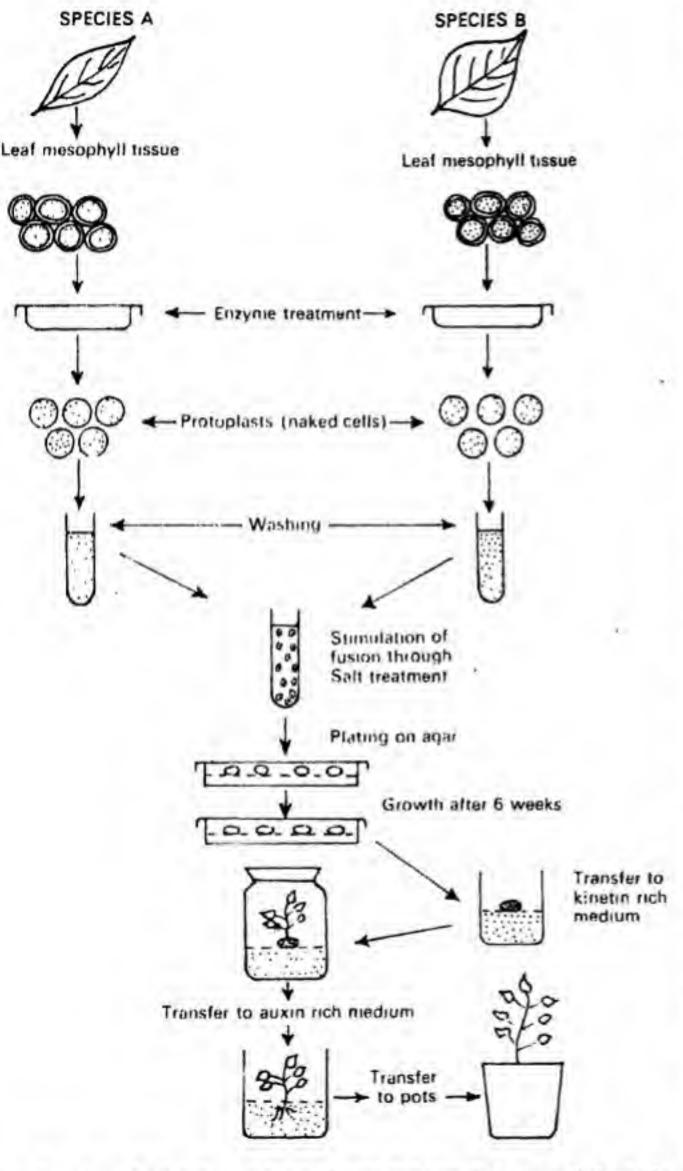
SATYESH CHANDRA ROY

MOST of our foods are either plant products or secondarily erived from plants. Our life would e better and richer if we had plants uited to our requirements. For this eason, scientists have been consantly trying new methods to produce lants with characteristics beneficial o man. Selective cross pollination, rafting techniques and also large cale artificial culture of desirable plant tissues have been tried with arying degrees of success. But hey have been restricted to plants enetically closely related. When hey are tried with distantly related pecies the crossing is either not uccessful, i.e., the plants are incomatible or the hybrid is sterile. This a major limitation of the common lant breeding methods developed o far.

To overcome the problem of incompatibility of plants the idea of omatic hybridisation is being deveoped. Getting impetus from the tudies on animal cells, the work on omatic hybridisation in plants is soing on with rapid pace in various parts of the world. This method has improved significantly with the development of the fusion techniques in animal cells. In 1960, a research team consisting of S. Sorieul, and F. Cornefert under the guidance of Georges Barski of Paris, France, made the important discovery that cells from two mouse tumour lines can be fused into one cell. An important achievement in the fusion technique was made by Henry Harris and J.F. Watkins of the University of Oxford in 1965 who used ultraviolet-inactivated Sendai virus to increase the fusion frequency. The Sendai virus, belonging to a member of the para-influenza group, is a spherical RNA-containing virus. It is surrounded by a lipo-protein envelope. It was previously known as haemagglutinating virus of Japan, i.e., in short HVJ. This method was then applied to other cells such as man-mouse, man-rabbit, man-chicken, rabbit and rat cells, etc. This scientific breakthrough of Harris and Watkins had its origin in the study of the life cycle of Myxo-

mycetes (by a German mycologis Anton de Bary), which showed that the multinucleated plasmodia ar formed through the fusion of single cells. The plasmodium is a vege tative body of the slime mould. is a coenocytic mass of high protoplasm containing numerous nuclei and vacuoles bu delimited only by a thin membrane Another important observation reponsible for this outstanding dis covery is the 'parasexual cycle' i fungi. The 'parasexual cycle' is term applied to the fusion of gene tically dissimilar nuclei, and re combination and segregation of the diploid nuclei so formed withou any proper meiosis. This who process occurs in the hyphae. Th first essential step in parasexua cycle is the heterokaryosis, i.e., th association of genetically differen nuclei in the same protoplast which is brought about by the fusion of somatic cells. In this method, again the fused diploid nuclei are not a stable as diploid nuclei in the usus organism which develops through

hri Roy works at Chromosome Research Centre, Dep 1 of Botacy, University of Calcutta, Calcutta-700019



g. 1. Procedures for isolation and fusion of protoplast from leaf mesophyll tissue of the

ormal sexual reproduction. In the arasexual organism the chromosones may be lost, and once one chromosome is lost others follow rapidly ntil only one genome is left. The uestion then arises as to the signi-

random combination of the chromosomes or segmental interchanges between the chromosomes of the two parental lines. So the objective of this method is similar to the

normal sexual cycle and the or advantage is that the sam output has come easily withou going through the time-consuming processes like meiosis fertilisation etc. In 1967, Mary Weiss working on collagen synthesis in Howar Green's laboratory of New Yor University along with H. Gree first isolated the viable human mous hybrids. They also first noted th gradual loss of human chromosome in man-mouse hybrid cells. Th location of certain loci for specifi functions on a particular chromo some was noted by observing the los of certain chromosomes and certai biochemically characterised fund tions. If the loss of chromosome in the hybrid cells could be preven ted and the viability followed by th regeneration of the hybrid cells to whole organism could be restored it would be a great step ahead i genetic engineering today. Th work on somatic hybridisation i plant is still lagging far behind i comparison with that of the mamma lian systems. The great potential of plant cell somatic hybridisation stu dies lies in the inherent totipotenc of plant cells. The totipotency is unique characteristic of the plan cells by which each and every cell of the plant, whether it is from the least root, stem, anther or egg cells, ca be regenerated to a whole plant is culture. This characteristic of th plant cell has a great advantage ove the animal cell where it does no occur. In India, the research in thi field has already been initiated a I.A.R.I., New Delhi, Jawaharla Nehru University and in our labora tory at Calcutta. The Indian legu mes of agricultural importance suc as Vigna sinensis, Pisum sativum Vicia, faba, etc., have already bee utilised for protoplast regeneration Although whole plant cannot as ye be regenerated from individual pro toplasts of any leguminous plant but the embryoid-like structures ca be readily produced. The experiment ith non-legumes has also been stared to introduce some of the genetic aformation of the legumes to nonegumes, useful for the nitrogenxation with microbes like hizobium.

The essential step in the somatic sybridisation is firstly the isolation of protoplast from a plant cell which is actually a cell without any cell wall. This naked plant cell resembles mimal cell. The next step would be the regeneration of the protoplast of a whole plant.

The isolation of protoplast through nechanical methods is known for early a century. But this method s obsolete now as it causes much lamage to the protoplast which reards its viability. However, only in he last decade there has been mared improvement in the isolation of protoplast through the combination of different types of enzymes by Prof. E.C. Cocking of the University of Nottingham, England. Incidenally, he is the first man to isolate he protoplast from plants successfully. There are several important steps in the isolation of plant prooplast.

The isolation of protoplast is generally carried out from the leaf mesophyll tissue, callus tissue, suspension cells in culture, etc. The most commonly used enzymes in the isolation procedure is Onozuka R-10 celluase and a pectinase like macerozyme. These enzymes are obtained from fungi. Along with the enzyme mixtures, certain osmolyticum is used to save the protoplast from any damage caused by the enzymes. The osmoyticum is the agent employed for plasmolysing the cells. A large number of osmolatica are generally used such as sugar, sodium chloride, potassium chloride, dextran, mannitol, sorbitol, etc. After removing the epidermis from the leaf material, the mesophyll tissues are allowed to incubate in the sterilised enzyme mixture at 27°C for 10-24

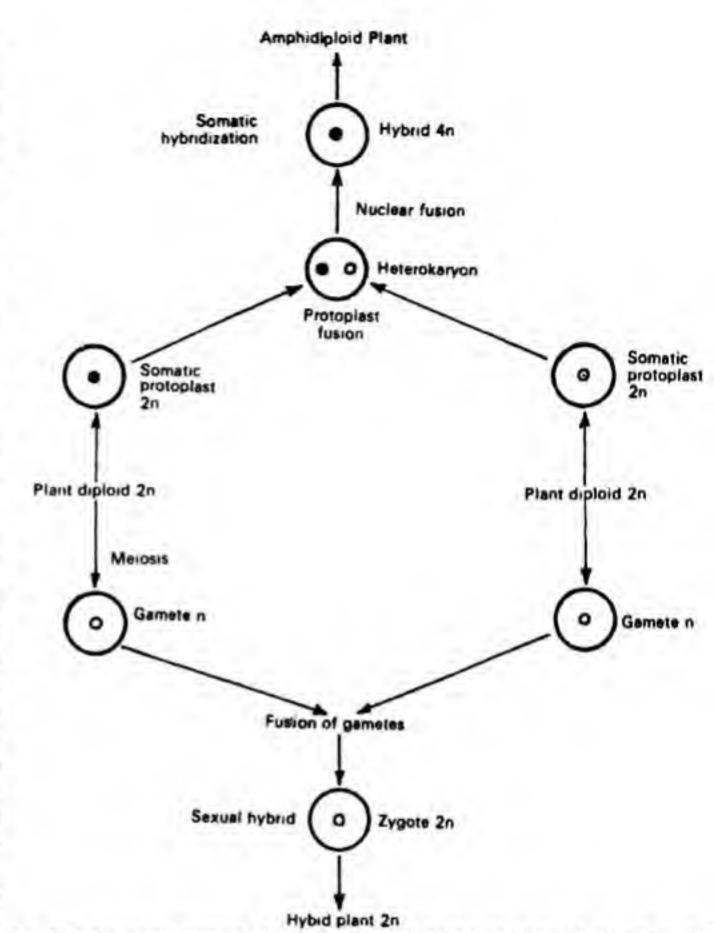


Fig. 2. Relationships between the sexual hybrid and the hybrid originated through somatic hybridisation

hours which varies from material to material. They are then centrifuged to remove the debris. All these steps are to be carried out in sterile conditions. Protoplasts of certain densities are then allowed to grow in a medium to form a mass of tissue for 3-4 weeks. These tissues are transferred first to kinetin rich growth medium, i.e., a medium containing high concentrations of a growth hormone kinetin and then to a medium containing high concentrations of indole-acetic acid (IAA), but kinetin under uncontrolled light conditions. These isolated protoplasts are regenerated into a whole plant (Fig. 1). The whole plant regeneration has been made from the isolated protoplasts of tobacco, car rot, petunia, etc.

Fusion studies

In case of fusion studies in plant cells, inactivated Sendai virus is no needed. But some of the inorganisalts such as calcium chloride, so dium nitrate, etc., or some polymer like polyethylene glycol, dextransucrose, etc., were used. Both intrand interspecies fusion is possible Fusion and mixing of cytoplasm does not usually result in nuclea fusion until the division starts in the nuclei. An important feature in that they can regenerate a cell was



I think you could hybridise the palm of with the betel leaf to solve be shortage of betel leaves the sub-continent"

within a day or two after fusion so that a heterokaryotic cell is formed in every case. It contains genetically different nuclei within a single cell. We see that fusion of the protoplasts followed by cell wall regeneration and nuclear division affords the opportunity for hybrid cell formation just as in fertilisation in which two gametes fuse to form a zygote, the sexual hybrid. (Fig. 2).

So, the major objective of plant cell somatic hybridisation is to overcome barriers to sexual reproduction, by eliminating the need for sexual ertilisation to bring together into one individual the genomes of diffeent species. There is often found ome loss of chromosomes of one parent after fusion. This directional oss of chromosomes in such hybrids nay found to be useful in plant sonatic cell genetics, though a general oss of chromosomes in such allopolyploids is not likely to occur. Allopolyploid is a type of polyploid n which the chromosome compleeents making up a multiple set are ot alike. It occurs through hybriisation from different species. In

plants, several allopolyploids are known to occur in nature as a result of rare sexual crossings and they are stable.

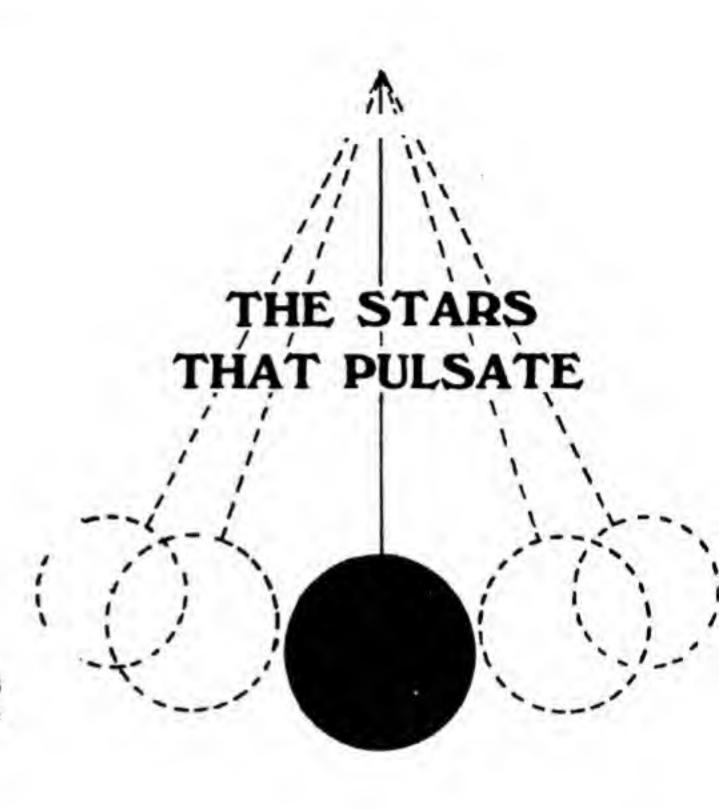
Primula kewensis (2n=36) is one such naturally induced amphidiploid. Amphidiploid is a type of allopolyploid where the somatic doubling in the F, sterile hybrid may result in the regular formation of gametes containing one complement of each of the parental types. A cross between P. floribunda (2n=18) and P. verticillata (2n=18) formed the sterile diploid P. kewensis (2n=18) with one genome from each parent. From a lateral bud on this plant there arose spontaneously a tetraploid shoot with two genomes from each parent having 2n = 36 chromosomes and thus making the plant fertile. So the improvement of plants through somatic hybridisation is feasible, though the adequate selection procedure for the successful culture of the hybrids is needed. In other words, most widely applicable selective procedures must be developed before this method may be generalized. A noteworthy step in this direction was taken by an American scientist P.S. Carlson at the Brookhaven National Laboratory, New York in 1972. He was able to select hybrids between the two closely related species of tobacco (Nicotiana glauca X N. langsdorfii) through protoplast culture and their fusion. This is the only known successful interspecific somatic hybrid so far. Several fusion studies were made, both intra and interspecific, in a number of plants such as Brassica, Avena sativa, Haplopappus gracilis, soybean, carrot, petunia, legumes, etc.

The symbiotic association between legumes and rhizobium bacteria has been maintained and studied in the laboratory conditions. If it is successful, it may create some new symbiotic systems which are not found in nature. There is some report of developing a symbiotic relation-

ship between Azotobacter vinelated dil, a nitrogen-fixing bacteria, and cells of carrot in a in vitro system. The composite cells are able to grow in a medium lacking nitrogen. Though it is still in a developing stage, this method may be tried in near future to other crop species allowing many plants to utilize atmospheric nitrogen. It may solve our fertiliser problem.

The somatic hybridisation throug protoplast culture may be able t form some new interspecific hybrid from the various sexually incom patible plants which was impos sible so far. This may introduc some new blocks of genes to th hybrid which is more beneficia to us. The technique is also valua ble in introducing the possibility o parasexual cycle which has been ex plained earlier in higher plants. Th development of such a cycle in higher plants will help in performing gene tic analysis of plants in vitro, a the nuclear fusion between the two plants, recombination and segrega tion take place through the uncon ventional methods. Normally, i requires sexual union and formation of a zygote which is a time-consuming as well as long drawn process. Even at the cellular level, the formation of heterokaryons has been found to be an important means for the demonstration of genetic complementation in higher plants as demonstrated by different workers of America and England. In 1973, Y. Yamada and M. Nakaminami of Japan observed a tendency of increase in alkaloid production through the isolation and fusion of protoplasts from alkaloid-producing plant cells cultured in vitro. It can be seen that the improvement in the method of somatic hybridisation of plants will ultimately help in modifying plant cells or whole plants in various ways which will be highly beneficial to us in future.

(Continued on page 502)



Today, a pulsating star is a powerful tool to measure astronomical distances

EPHEID study is one tool whereby we can by the strength of our own thought, ascend through universe after universe," wrote Edna E. Kramer, a prominent mathematician in the book The Mainstream of Mathematics. Indeed, oday the pulsating stars, of which Cepheid is one group, is a powerful tool to measure astronomical distances. In whichever systems they ire found, globular clusters or spiral ebulae, the distances of those ystems from the earth can be easily letermined. Besides, the study of the tars is no less interesting. It enables is to comprehend the stellar evoluion and its mysterious pulsation oth of which, in turn, helps to nderstand better the internal strucure of stars.

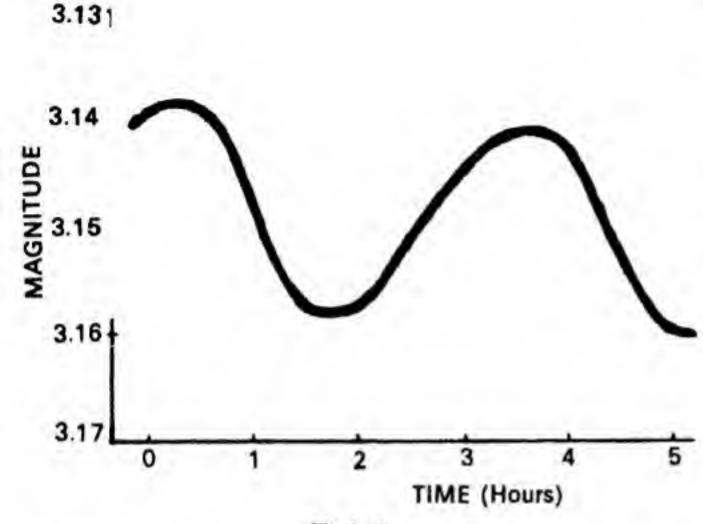
Before anything is said about these tars, their exact distinction from

other similar ones, classified as variables, is of paramount importance. By a variable star, it is understood that the star fluctuates in brightness. There are four modes by which it can do so. First, it may not be a single star: there may be two or more stars which rotate to eclipse each other (in our line of sight) to produce periodic fluctuations in the emitted light. They are called eclipsing variables. Secondly, it has hotter or colder regions on the surface whose rotations, like faculae or sunspots on the sun, create changes in the intensity of light, e.g., pulsar. Thirdly, it explodes time and again, when it is called an eruptive variable. Lastly, it may contract and expand alternatively to brighten and dim so as to pulsate in light. This last variety, in which there are changes in the luminosity of a star because

of some internal reactions, is calle pulsating star.

In 1596, long before the advent of telescopic studies of the heaver David Fabricius discovered the fir pulsating star though he did no know then the true nature of h discovery. He detected a star i constellation Cetus which was no present in the contemporary char of the heaven. Though he notifie its existence in the chart, it was no until forty years later that the sam star was recognised as a pulsatin star. Delta Cephei was the nex pulsating star that was discovere in 1784. With the passage of time more pulsating stars were dis covered. Classical Cepheids, a grou of stars of long pulsation-periods though relatively few in number bu easily detectable by a naked ey because of their brilliance, wer

nri Salwi is on the editorial staff of Science Reporter.



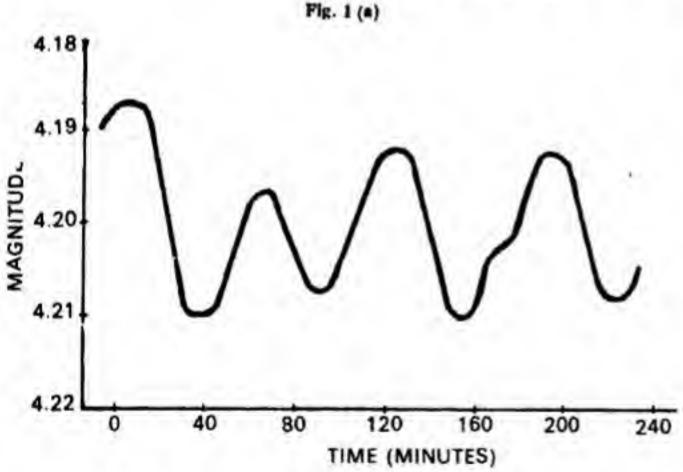


Fig. 1 (b)

discovered in the beginning. As about these stars is that their disophistication in photographic and photo-electric techniques increased, Cepheids, much faint stars of short pulsation periods but present in bundance in the universe, were discovered at an ever-increasing ate.

Even today the number of pulsatng s'ars i on the rise. There are, has been observed, differences in harr cteristics amongst them also. lowever, one point to be appreciated

coveries had not been merely additional entries to an already existing long list of stars. Their discoveries had, in fact, revolutionised our ideas about galaxies and the universe. Every newly discovered pulsating star provides us a new opportunity to fathom the depth and nature of the universe.

Pulsation and classification

The waxing and waning of a pulsat-

ing star is apparent from its ligh curve, the graph between its magnitude de and the time [(Fig. 1 (a)]. The magnitude is nothing but a measure ment of the brightness of a sta If a star is one magnitude more lum nous than another star, it is usual 2.512 times brighter than the other Moreover, the smaller the magnitud of a star, the brighter it is. In other words, the scale of magnitude rur opposite to the ordinary scale. For instance, a zero magnitude star brighter than a one magnitude star a minus one magnitude star is brigh ter than a zero magnitude star; an so on. In the light-curves, the mag nitude of the pulsating stars under goes a maxima and a minima, which repeats regularly. In some case the extremums are also constan

Judging the state of activity of these stars from the light-curves, is exactly like that of a swingin pendulum. This analogy, however evokes one obvious question. As pendulum needs a driving force to maintain its swinging, what is tha force in a pulsating star?

That force, which must be mecha nical in nature and which must b continuously feeding energy to the star to sustain pulsation, is only to timely and therefore must be as outcome of a complex activity presen inside the star. Its details are dis cussed in the next section. However at this juncture, the light-curve o Epsilon Cephei [Fig.1 (b)] need close scrutiny. The question tha draws attention forthwith is: why i it so? For answer, it is better to consider an analogical situation.

Every one is acquainted with the modes of air vibration in a closed organ pipe. It will be recalled tha the modes rely on where the driving force is applied, and how much. The fundamental mode is achieved i air is blown in gently at the mouth of the pipe. The harmonics or over tones 3n, 5n, 7n,...etc., are created if air is blown in strongly. So nodes, where the strength of force is

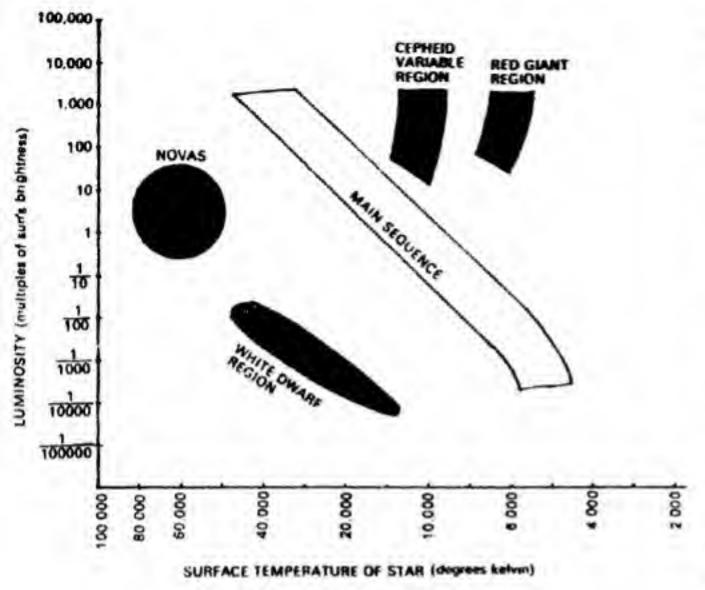


Fig. 2. Hertzspring Russell Diagram

ighest and the amplitude of displacement zero, and antinodes, where he magnitude of force is zero and implitude of displacement the highst, are produced because stationary vaves are formed inside the organ pipe. A similar kind of waves can e conceived of as forming inside a oulsating star. The centre of the tar, where a small sphere of gas s confined, has conditions similar o the closed end of the pipe, whereas he surface of the star which is open o space serves as the open mouth f the pipe. Hence, a star vibrates r pulsates in the fundamental or armonics note according to where orce is applied and how much. Delta or Beta Cephei [Fig.1 (a)], or example, are those stars which oulsate in the fundamental or harmnics. On the other hand, Epsilon Cephei [Fig. 1(b)], whose light curve s irregular, has pulsation which is superposition of two or more armonics.

From what has transpired above, is easy to convince oneself why here are pulsating stars with varied

pulsation-periods. Moreover, the behaviour of these stars is similar to that of a number of balloons that are being inflated-deflated alternati-The pulsation period of vely. these balloons would be different. It depends for one thing on the size of a balloon and, secondly, on its deflation-inflation mechanism. For a pulsating star, the pulsation-period varies in accordance with the star's range of magnitude-fluctuation (how much it can expand and contract) and physical properties (the driving mechanism). In the light of these factors, a pulsating star is classified according to the pulsating period, range of magnitude-fluctuation and physical proparties, e.g., mass, age and temperature. However, it still remained to be seen what that inflation-deflation mechanism is which drives a star to pulsate.

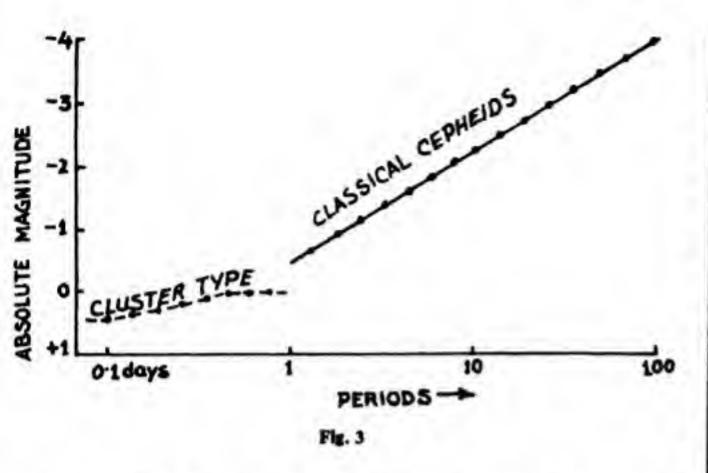
Palsation theory

That a pulsating star actually contracts and expands was first visualised by R.W. Ritter in 1879. Sir A.S. Eddington, the eminent astroplaced this idea on a concrete footing. His contribution is substantial taking into consideration the meagre data then available about the inside of a pulsating star. Although his work was incomplete, it doubt lessly paved the way for the commendation of astronomers/astrophysicists to take up the subject seriously. Today, with enormout data of varied stars available, the astronomers have modified and ar still modifying Eddington's theory in greater detail.

A star, like our sun, is a hall o hot gases. The gaseous pressure inside expand it increasing th radius, while decreasing the tempera ture to become dim (brilliance o fourth power of temperature). Be cause of inertia, the star goes or expanding, to overshoot its equili brium state (when it is not pulsating until the inside pressure equals that of the outer space. Thereafter, the star starts contracting because o gravity-decreasing the radius while increasing the temperature, to become bright. Because of inertia, again the star over-contracts its equilibrium size to become very bright, and their the same cycle sets in expansion (dim) and contraction (bright) alter natively. During the pulsation the gas attains a velocity of about 30



'You are destined to be a star, you are pulsating fast"



m/sec. There is a difference of bout a thousand degrees of temprature between the two extremes.

A star, or for that matter a penduum, oscillates only if some forces irst spur it to do so, and, secondly, hese forces are maintained, i.e., ome energy is continuously fed in, vithout which the dissipative forces and friction stops the pulsation. such a phenomenon is required of he model for a pulsating star: that when the star is hot and compressed, t should absorb excess heat; when old and expanded it should release excess heat. That is to say, a heat ngine is required which can convert fraction of its abundant radiant eat into motion.

What is the form of a heat engine?



Whenever he discovers a pulsating tar-his pulse beats faster"

Eddington took it as a 'valve' near the surface of the pulsating star. It functions in such a manner that when hotter and compressed it is closed to trap excess heat; when cold and expanded, it is open to release excess heat. But what does really create a valve mechanism? The answer is partially ionised zones. They are the zones where the atoms of a specific element are present in two states: the atoms in one state are stripped of one or more electron than the atoms in the other. When a partially ionised zone contracts or gets compressed it liberates energy which is mostly dissipated in ionising the rest of the un-ionised gas, while a fraction of it heats the gas. The overall effect is that the gas cools down and therefore absorbs the excess heat, as it should in the compression of the valve or heat engine. The absorption of the excess heat raises pressure within the zone to create a 'lift', which further builds up and is maintained to sustain pulsation.

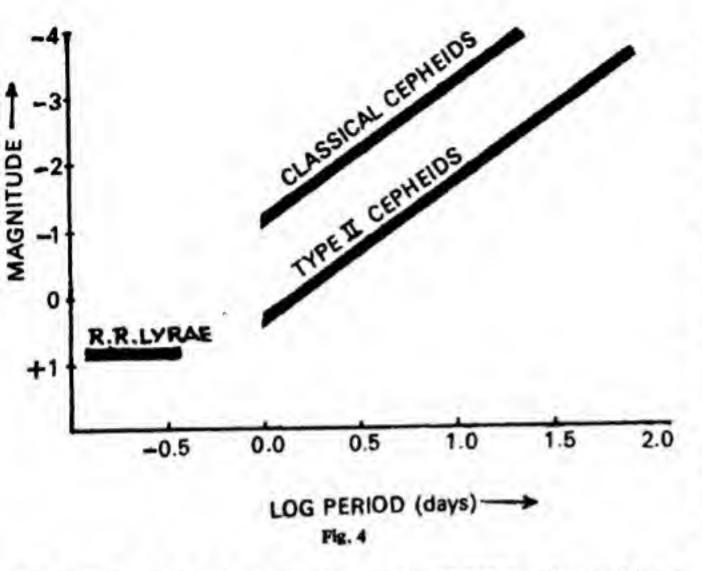
With an effective surface temperature 7000°C, a star, it has been analysed, is capable of producing the required ionization zones. These zones are situated in the star such that they are quite near the surface to produce large pulsation-amplitude. On the other hand, they are situated

Is sun a variable star?

SUN is a star that twinkles. It twinkles, but according to cosmic standards. The fluctuations in its brightness can be detected over a period of several centuries and not over seconds as in case of stars that fill our night skies.

John Eddy of National Center for Atmospheric Research, Colorado U.S.A., (Science, March 10, 1976) has put forth some convincing arguments to this effect in the talk he delivered in a recent meet on the sun. He is, of course, not the first to claim so. In the nineteenth century, two scientists, Gustav Sporer of Germany and E.V. Maunder of Britain, arrived at the same conclusion, which was then not taken notice of.

The conclusion is based on the study of sunspots' cycle, auroral phenomena, coronal streamers, carbondating of tree rings and earth's past chimatic changes. They are all directly or indirectly affected by the activity of the sun. A scan through the old records, mostly of the past millennium, has revealed the sun to be brightest or hottest during 1645-1715 and 1100-1250 and dimmest or coldest during 1460-1550. Although observational evidences, e.g., sunspots, coronal streamers, can be doubted as precision instruments were not available then, there can be no place for a doubt for the chemical evidences based on carbondating of rocks and tree rings. They indicate variability of the sun equally well. As a result even the constancy of the solar constant, the sun's output of energy, is now doubted. However, still much is left to be known, for we have not yet studied the sun for a considerable time to conclude that it is really a variable star. If in time this is proved true, it will have far-reaching consequences on the present models of sun's interior and atmosphere. D.M.S.



deep enough in the star to possess sufficient density (mass) and momentum to drive and maintain pulsation. Further, a star pulsates in harmonic mode if the zones are relatively close to the surface. It pulsates in the fundamental if the zones are relatively deep inside.

The next question that arises is: of what elements ionisation zones are made of? In Eddington's time nothing much was known about the chemical composition of stars, so he didn't provide the answer. The answer came as research progressed in this field. It was theoretically shown that the second ionisation zone of helium (where helium has lost two electrons) is capable of causing a star to pulsate. This result was arrived at by the study of Cepheid stars. Moreover, theoretical studies by R.F. Christy of California Institute of Technology on R.R. Lyrae led him to conclude that they contain helium in abundance, about 30 per cent by weight. Further, he arrived at the following estimates for the formation of various zones inside a star: hydrogen ionisation zone is created at a temperature of about 10,000°K; first ionisation zone of belium (He stripped of one elec-

tron) at 12,000°K and second ionisation zone of helium at 40,000°K. So, no sooner than these zones are created inside a star than it starts pulsating.

The factors which decide whether a star would pulsate or not have been studied. The star may be so hot that hydrogen-helium ionisation zones lie close to its surface where the density or mass is too low to drive pulsation. Or, the star may be so cold that the zones lie deep inside the star where the density or mass is too high to initiate pulsation. The stability of the sun, which is also considered a cold star, is because its energy does not entirely flow by radiation but due to convection also. The convection, a phenomenon still incomprehensible to astrophysicists, does not allow the valve to function. Or, lastly, the star has no helium ionisation zone. The remaining one hydrogen zone is too close to the surface to initiate and maintain pulsation.

However, there is yet another aspect of these stars that at one stage was thought to have disproved Eddington's pulsation theory.

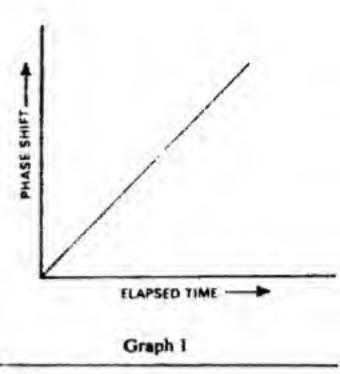
Like every other star in the universe, the pulsating stars too exhibit certain spectral lines. In this case, the lines oscillate rhythmically because the surface of the star expand and contracts (Doppler effect). Moreover, it was believed that the star surface stops expanding or contracts when their sizes are at maximum or minimum respectively. However, in the wake of spectral studies of the star's surface movement, it has been found not to be so. The velocity of the star surface while expanding or contracting is the highest when the star is of maximum or minimum size respectively. In other words, the pulsation at the star surfaces is not keeping up with the pulsation at the core. This was the baffling point which the pulsation theory could not throw light on. M. Schwarzchild of Harvard College Observatory, U.S.A., elucidated it in 1937. He claimed that the pulsation theory works out well inside the star but not in the outermost layer, where his theory comes into effect. To have an idea of its salient features, consider a balloon in a tub of water. If, somehow, it is made to contract and expand inside the water, it will produce waves or ripples that will rise to the surface. When a wave reaches the surface, there is a maximum pressure. In a similar manner, a star becomes bright when such a wave reaches its surface, and, of course, it has then the maximum velocity at the surface as required. This solves the dilemma, and the idea very much fits in with the pulsation theory.

Stellar evolution and its measurement

A human being grows in a set pattern—childhood, youth and old age. There is no escape from that. However, some human beings become preeminent as artists or writers or politicians. The rest lead a stereotyped life. The deciding factors which make a man renowned are hard work and application of intelligence (and also perhaps the inexplicable factor 'luck'). For instance, if everyman's intelligence

Table I

me elapsed	Time registered clock B	Phase shift or Comulative error in comparison to standard clock A		
eroth day	86400	0		
irst day	86401	1 sec.		
cond day	86401	1 + 1 = 2 sec.		
hird day	86401	1+1+1=3 sec.		
th day	86401	1+1+1+1=n sec.		

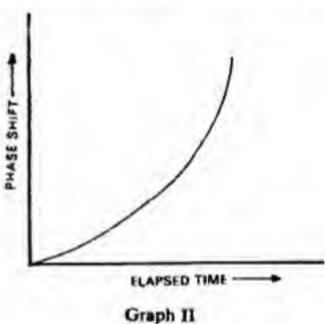


-	-		
	-		

No. of the second			
Time registered clock C	Phase shift or Cumulative error in comparison to standard clock A		
86401	I sec.		
86403	1 + 3 = 4 sec.		
86405	1+3+5= 9 sec.		
86407	1+3+5+7-16 soc.		
8640	1 + 3 + 5 + nº sec.		
	86401 86403 86405 86407		

Therefore Phase shift a (clapsed time)

Therefore Phase shift as (clapsed time)



f a graph is plotted between the wo variables for the entire mankind, t does not appear different from the one shown in Fig. 2. Ninety-nine per cent of the people are classified in the 'crowd' category or the main equence as shown. Those few who have gained prominence, whether by notoriety or virtuousity, are out of the 'crowd' forming separate groups.

Hertzspring-Russell (H.R.) diagram (Fig. 2) is a similar kind of chart for stars. In it, a star has been plotted according to its luminousity and surface temperature. Most stars, like human beings, lie in the main sequence. But a few form separate groups, e.g., novas, white dwarfs, Cepheid variables, red giants, etc. The pulsating stars are therefore a special type of stars and have a specially assigned region in the H.R. diagram.

It has also been observed that some tile known human beings have become famous overnight and have also faded soon into oblivion. They are called to have had a 'meteoric fame'. Such is the case of pulsating stars also. They are actually 'ordinary' stars in the main sequence which suddenly acquire some temperature conditions (in case of human beings -hard work) inside them to start the pulsation. As soon as those conditions cease to exist the star returns to the main sequence to follow a 'normal life'. The duration of acquiring 'meteoric fame' for an ordinary star is small compared to its own life-time. Say, for a star of 100 year's lifeperiod, it pulsates for a time not more than what a camera takes to snap a shot. Recently, a star, 11 Cepheid R U Camelopardalis, was noticed to have stopped pulsating. Now, however, it is under the strict surveillance of astronomers. This is the case of a star which has achieved 'meteoric fame' twice within a very short period of its life.

Coming back to human beings, it has been observed that by and large with age all become less hard working and, say, less intelligent, because after all, a man is always growing old. The same holds good in the case of stars: whether it is in the main sequence or pulsating region or regiant strip, it is evolving or ageing.

When a star is born and brimming with energy, it starts at the upper left corner of the H.R. diagram With the passage of time, its energy 'evaporates'—its luminousity and surface temperature decrease gradually. The hydrogen inside fuses to form helium, which is further converted into carbon and heavier elements. Here it reaches a 'dead end that is, the extreme right corner of the H.R. diagram, to become a tindwarf star.

As the evolution of a star bring about radical changes in its internastructure, the pulsation-period als undergoes variation in a pulsating tar. This is apparent from the following:

In an organ pipe we know that: The period of vibration of the air column of the column length Correspondingly,

The period of pulsation of a starce he star radius (raised to the power of 1.5)

As a star's luminousity of the surface

c(2m(star's radius)^a
c((star's radius)^a
....2
Also, a star's luminousity o(effective surface temperature (mentioned

Therefore, from 1, 2 and 3, the oulsation-period of a star is related to its luminousity and effective surface emperature.

In general, the rate at which pulsaion-period changes is very small, ay, of the order of 1 second/century. So, the measurement of such a small quantity is something interesting to know.

Consider for simplification, three locks: A, B and C (see Tables). The lock A is a standard clock which neasures a day to be of 86,400 secs. The clock B, however, measures a lay to be of 86401 secs; i. e., loses one second each day. The hird clock C slows down every day y 2 seconds; to begin with, it neasures a day to be of 86401 secs. The Tables I and II give the timeecord of clock C and clock B during finite number of days. In the third olumn of each table, how these two rroneous clocks differ from the clock in measuring the period of a day is iven. This cumulative error, which lepends on the passage of time, is alled phase-shift. It indicates the mount of shift in pulsation-rate a tar undergoes. Let us now assume he clocks as star B and star C.

First note-their initial pulsationberiods and assume them to be tandard. Say, for instance, the tandard time to be that of our tandard clock A—86400 secs. Thereafter, we go on noting their pulsation-periods, as we had done in the case of clocks for each day.

When substantial readings have been recorded, a graph is plotted between the elapsed time and the corresponding phase-shifts. If the graph resembles I, i.e., a slope, the pulsation-rate of star B is constant. If the graph resembles II, i.e., parabola, the pulsation-period of the star C is slowing down. The rate at which the pulsation-period is decreasing enables us to deduce the evolution-rate or the aging of concerned star. This is one of the greatest benefits that accrue from the study of pulsating stars.

The past studies have brought in interesting results. The study of 150 short period Cepheids (globular cluster Omega Centauris) by E.G. Martin, between the years 1896-1935, has revealed that 19 of them have undoubtedly undergone changes in their periods. The pulsation-period of R.R. Lyrae stars have also been found changing. These studies were crucial in proving that stars are aging—the hypothesis which previously was not supported. In some cases, stars have been found erratic in their evolution process, i.e., their pulsation-periods remain constant for some duration, then change abruptly, to remain constant again.

Pulsating star as an astronomical tool

In 1912, Miss Henrietta S. Leavitt, a worker at Harvard Observatory, made telescopic studies of 25 Cepheid variables located in the same star cluster, the Lessar Magellanic cloud. When she arranged the Cepheids in order of increasing pulsation-period, she found their magnitudes also increased. As this cluster of stars was like a bunch of bulbs at the same distance from the observer, any difference in brightness among them could not be attributed to a factor other than their intrinsic brightness. A graph was, therefore, plotted by her, which turned out to be approximately a slope, to indicate a perfect relationship between the magnitude of a star and is pulsation-period (for mathematical proof, compare the equation (1) with (2)). It was Prof. Harlow Shaples a worker at the same observators who in 1915, with more data at han attacked the above relationship thereby putting the relationship of a stronger footing (Fig. 3). Later, it made full use of it in evaluating the size and characteristics of our galax and the universe.

The period-luminousity law (Fig. 3 is a relation between the absolut magnitude of a star and its pulsation period. How it enables one to fin the distance of a pulsating star and thereby of the location (cluster of nebulae) needs elaboration.

Consider the expression

$$\log ! = \frac{m - M + 5}{5}$$

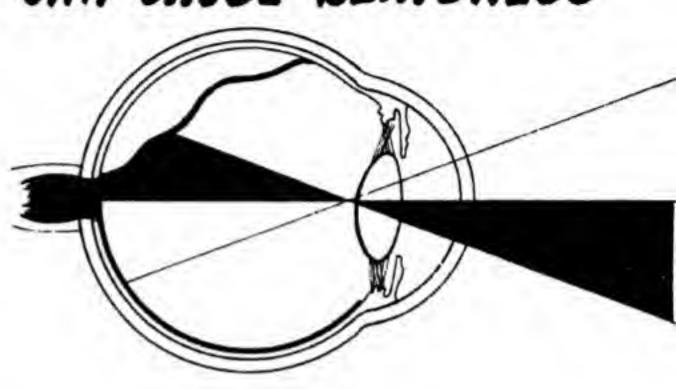
where m, M and r are respectively the apparent magnitude, absolute magnitude, and the distance in as astronomical unit (parsec). So, is m and M are known, r can be calculated.

The apparent magnitude is the brightness of a star as seen from a distance; the more distant the star the less is its apparent brightness Absolute magnitude, on the other hand, is the actual brightness of the star, which, of course, is independen of any factor. The measurement o apparent magnitude is easy, bu measurement of absolute magnitude is difficult. This is where period luminosity law stands in good stead First, pulsation-period of the star i determined, and from the law (Fig.3) the corresponding absolute magni tude is determined. From the above equation, distance of a star from the earth is calculated.

H.C. Arp of Mount Wilson and Palomar Observatories modified the form of period-pulsation law. It is now a relation between the logarithm of the pulsation-period with median absolute magnitude. Median abso

(Continued on page 484

RETINAL DETACHMENT CAN CAUSE BLINDNESS



Retina of the eye, analogous to the film is a camera, is vital for vision. It can detach from the choroid. Its detachment, if not treated promptly and properly, can lead to total blindness

RETINA is to the eye what the photographic film is to a camera -only more complex (Fig. 1). The points of similarity between a human eye and a camera are many. The photographic film is held stretched on he back of camera, a light-tight box, o receive the image focussed on it by he lens system of the camera. The etina is similarly placed on the back of the eye to receive the image ocussed by the lens system of the ye. While the photographic film meant to retain a single image ermanently, the retina receives and ransmits to the brain successive mages as the eye looks on, somewhat imilar to a television camera. The perture of the camera diaphragm

has to be manually adjusted to permit only certain quantity of light into the camera to give a good photograph in a particular film. The aperture (called pupil) in the iris (diaphragm) of the eye is automatically adjusted, similar to certain automatic cameras available nowadays. Similarly, while the focussing is done in most cameras by the photographer, the focussing of the eye is automatic through certain changes in the human lens. In order to prevent scattering of the light inside the camera, which could fog the film and give a hazy photograph, the inside of the camera is covered with absorbant black paint. For precisely similar reason, just outside the retina, the eye has

been provided with a dense dark pin ment in the pigmented epithelius and choroid (Fig. 2). Unlike photographic film, the retina is living tissue requiring a huge quantit of nutrition (fuel) and oxygen for it survival and function.

The most sensitive and complete outer portion of the retina has no blood vessels to supply it oxyget or nutrition directly. For these the retina has to depend on the choroid which is highly vascular (with pienty of blood vessels) for the sole purpose of feeding the retina. For the retina to be able to use the nutrients, it must remain 'position'—in close proximity with the pigmented epithelium and the

r Patnaik is Astt. Professor of opthlmoology (Retina Care) at Maulana Azad Medical College and Associated Irwin and G.B. Patopitals, New Delhi.

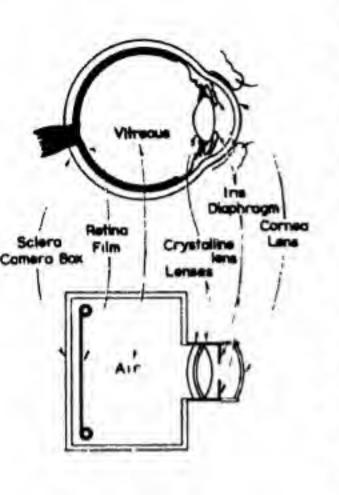


Fig. 1

horoid. Under certain circumstanes, discussed below, the retina gets eparated (detached) from the pignented epithelium and the choroid. The condition is known as 'Detachnent of retina'.

Anatomically there is no definite attachment between the retina and the pigmented epithelium, the correct expression should have been separation of retina rather than detachment of it. Immediately following the etachment, the retina fails to eccive or transmit an image with my amount of clarity. When the

detachment is partial involving a part of the retina, the corresponding part of 'field of vision' (the area visible) is lost (Fig. 3). When the central (macula)—the area of the retina used for seeing things we 'look at', things we wish to see—is detached, the result is catastrophic. As the retina gets lifted up, it relapses into wrinkles and folds. The patient sees things wavy, tilted and distorted before total loss of vision. Only a strong source of light or a bright object can be seen. When the retina is totally detached, all vision is lost. If the retina can be reattached quickly, most of the vision can be recovered.

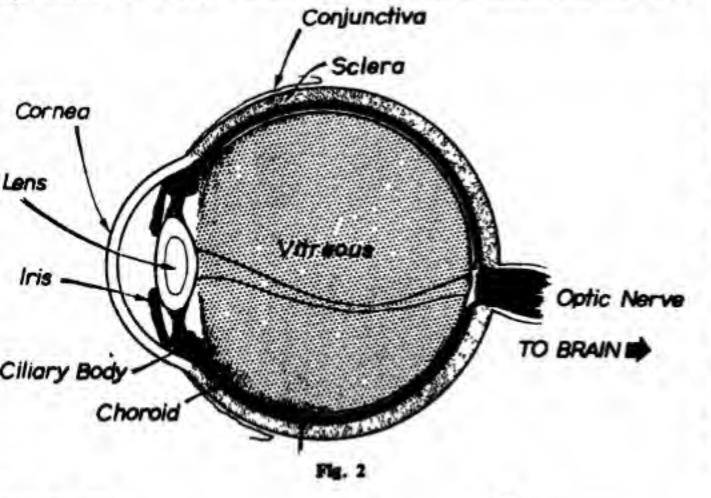
However, if the retina remains detached from the choroid, i.e., away from its source of nutrition and oxygen, its outer layers containing the important visual elements slowly die and degenerate. The retina could be dead completely but for the fact that its inner layers have their own vascular supply which can delay death but cannot save it. The result is total and permanent blindness. Therefore, the longer the retina remains detached the greater is the degeneration and the lesser the chance of visual recovery. Unfortunately only 20% of my cases have reached me within a weak of the retinal detachment. It is hoped that with increasing knowledge of this condition, patients may seel treatment more promptly.

Causes of retinal tears

Tears or holes in the retina do not develop in normal, healthy eye except when the retina is directly pierced as in perforating injuries of the eye or when the retina is stretched beyond endurance in the terrible distortion of the eye following powerful blows to the eye as among boxers.

Degeneration of the retina result ing in its weakening, degeneration o the vitreous resulting in its partia collapse and adhesion of the degener ated vitreous to the retica are some of the most important factors which predispose the eye to the develop ment of retinal breaks. Actua breaks could develop if individual with such eyes receive a jolt or jerl or are subjected to sudden accelera tion or deceleration while travelling in a jerky vehicle (i.e., jeep or i scooter) on a rough road, or in a ca which speeds up too fast and i suddenly brought to a halt. Even bump on the head, a fall in a slipper bathroom, or a massage by a enthusiastic barber could precipitat retinal tears.

The degeneration of the retin and the vitreous is determined by a genetic abnormality. Such as abnormal gene is closely related to which another abnormal gene causes short-sightedness (myopia) Therefore, most cases of vitreo retinal degenerations (VRD) are to be seen among the myopes speciall the progressive type (patients needin rapid change of glasses) and hig myopes. However, such degenera tion is also possible in people wit normal eye sight. These are often the members of a myopic famil carrying the gene of VRD be not of myopia.



Besides myopia, old age and cerain ocular inflammations (chorioetinitis) are the common causes for itreo-retinal pathology. If a cataract evelops in such an individual, an peration is done to remove the ens. This causes the vitreous to shift orwards. In a bad operation the itreous flows out of the eye during he cataract operation producing a oull on the retina, and chances of levelopment of retinal tears inrease. In a recent analysis of cases of retinal tears registered at the Retina Care Unit of the Department f Ophthalmology, Maulana Azad Medical College, myopia accouned for 68%, the cataract operations aphakia) for 16% of cases and rauma accounted for 6%. With an nticipated increase in the number of cataract operations in the coming ears, aphakia may become the nost important cause of retinal etachment in India. lly if the quacks and the old ashioned surgeons, who are extrenely casual about vitreous loss and listurbance, are encouraged and forified for their 'instant' surgery, lindness due to retinal detachment vill be on the increase.

itreous in the mechanism of deveopment of retinal tears

Vitreous is a transparent jellyike tissue filling the space bounded by
ens in front and retina behind.
Normally it has no firm attachment
to the retina which it supports. The
ritreous consists of molecules of
nucopolysaccharides, swollen with
vater (hydrated), suspended in a
neshwork of collagen fibers. In a
nealthy state their arrangement is
compact and looks like a soft transsarent jelly.

When the vitreous undergoes egeneration, the fat mucopolysacharide molecules dissolve to form tockets of fluid. The collagen network collapses and the vitreous hrinks. A sudden movement of the itreous cavity of the eye would

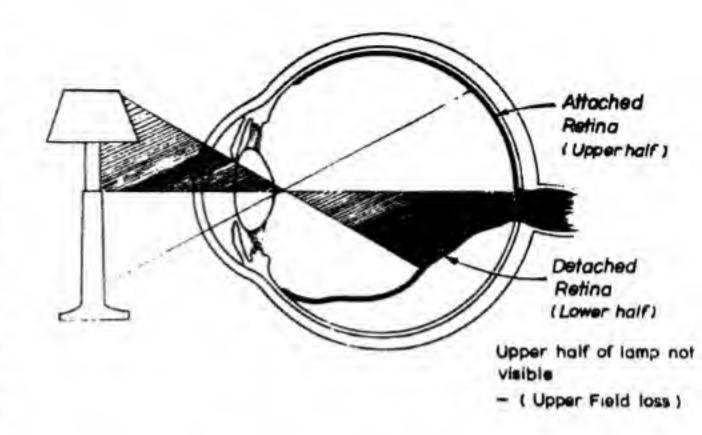


Fig. 3 Field loss in partial detachment

produce differential movement of the collapsed vitreous in relation to the tunics of the eye including the retina. If the vitreous has any abnormal adhesions to the retina, it would produce a tear (Fig. 4).

Tears do not by themselves lead to detachment. When fluid vitreous exists close to the tear, it flows through the tear to lift the retina and accumulates behind it starting detachment (Fig. 5). As more fluid accumulates lifting more of retina, the detachment spreads. In decourse detachment becomes total There is usually a considerable time interval between development of a retinal break and the onse of retinal detachment. If during this time interval the tear is detected it can be sealed without an operation by focussing strong light (Photocoagulation) (Fig. 6) around it could by freezing it (Cryopexy) (Fig. 7) Also dangerously degenerated area of the retina which could breat

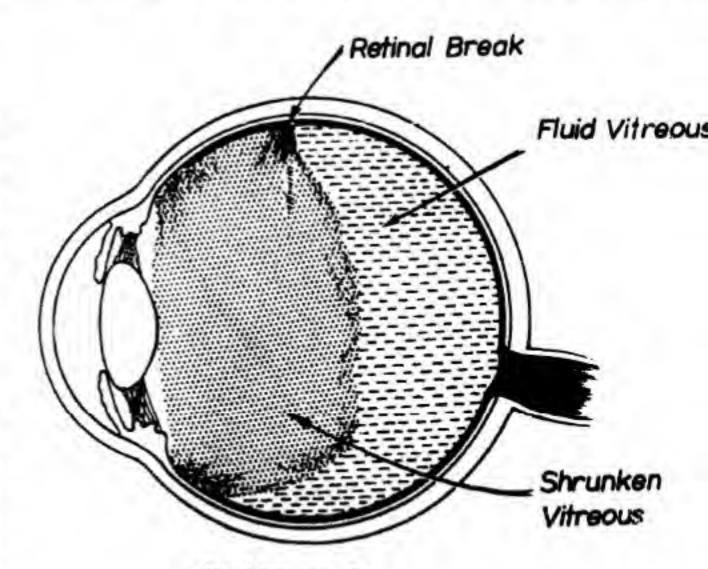


Fig. 4 Vitreous pull

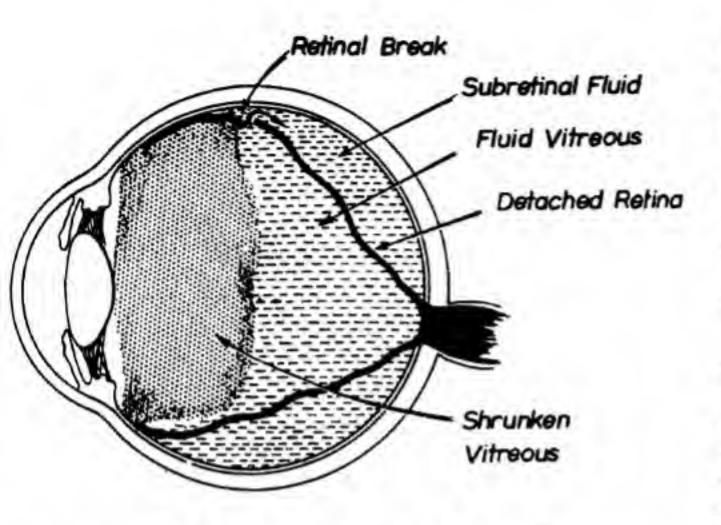


Fig. 5. Fluid vitreous causing retinal detachment

down to cause retinal breaks can similarly be treated to forestall a detachment. This is the basis of a system for prevention of retinal detachment through prophylactive preventive) therapy.

Cause of retinal detachment

The cause of spontaneous or prinary retinal detachment was shrouled in mystery until Jules Gonin 1870-1935), the great Swiss ophthalnologist, at the beginning of this entury made a thrilling observation. t laid the foundation of the modern letachment surgery. He noticed hat often ophthalmologists recorled a tear or a hole in the etina in cases of retinal detachnent without assigning any signicance to it. In his view, if retinal oles are the cause of retinal detachnent, every case of detachment must ave a retinal tear. He began rexamining all cases of retinal detachnent where no holes had been etected. Many of the cases re-examied revealed retinal holes. He conluded that retinal hole or a reak is the cause of primary retinal etachment.

Treatment of retinal detachments

A surgical operation is the only treatment for retinal detachment. This involves essentially four steps:
(1) exposure of the back of the eye globe by cutting through the thin membrane, conjunctiva, which covers the front half of the globe and then continues to cover the back of the eyelids, (2) producing a choroidal reaction (a sticky surface) under the retinal tear

so that retina around the tear could stick to the underlying choroid ultimately forming a firm chorio-retinal adhesion, (3) producing a scleration buckle (bulge) which pushes the choroid with the sticky surface to wards the retina with the tear, and (4) removing the fluid which has accumulated between the retina and the choroid so that the retina can settle on the sticky choroid—made easier by the buckle.

The details of the steps ar

Exposing the back of the eye globe. The lids are kept open by 'retractors or 'speculum'. The conjunctiva is cut close to the cornea and lifted up to expose the outer coat of the eyeball-sclera and the eye muscle attached to it.

Producing a choroidal reaction Choroid is like a carpet of blood vessels where the soft surface is inner most and is close to the retina. It consists of loop and masses of fine thin-walled blood vessels (capillaries) When damaged, these capillaries leak a sticky fluid (exudates) or to which the retina with the team can stick. The choroid capillaries can be carefully damaged either by heating or freezing. Heat can be

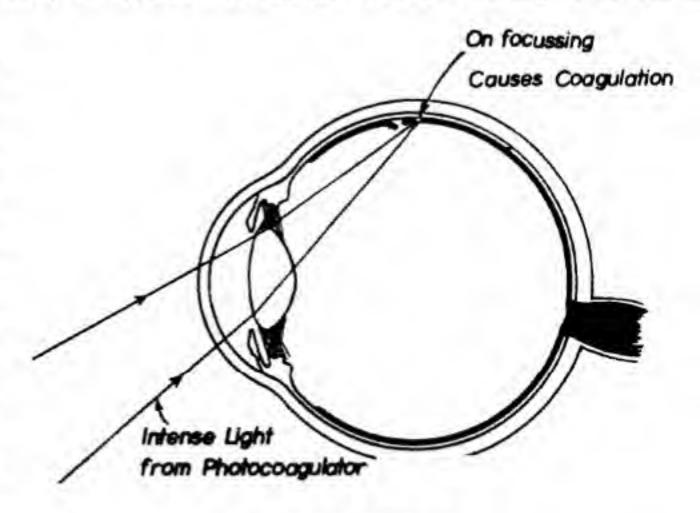


Fig. 6. Photocoagulation

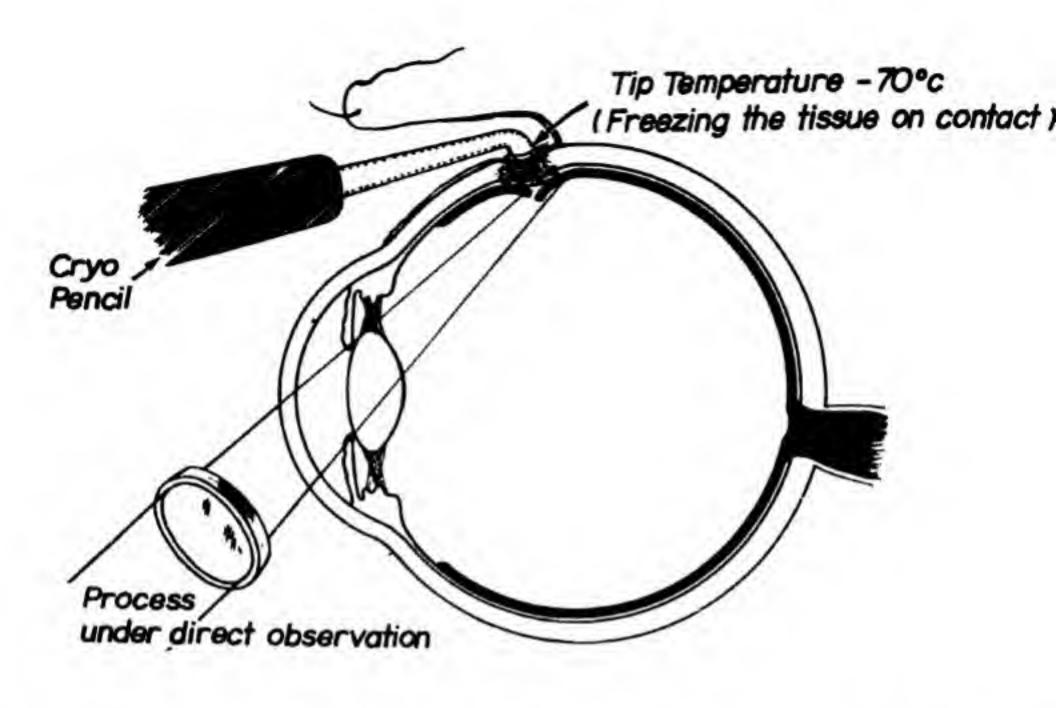


Fig. 7. Cryopexy

produced to damage the choroid capillaries by two methods:

DIATHERMY. A diathermy appliator (electrode) is positioned on the outside the globe, and clera high frequency (13.56 MHz) Heat is urrent passed. produced as the high frequency labours through the urrent esistance offered the body by issue as a semiconductor. The process is known as diathermy coagulaion. By careful regulation of the urrent made to flow through the clera and choroid an appropriate reaction' can be produced. Diatherny is one of the oldest and surest mehods to produce choroidal reaction. et, it has the disadvantage of amaging the sclera which beomes weak, and heating the vitreous ould shrink it further. With ninimal use of diathermy, these isadvantages can be minimised.

PHOTOCOAGULATION. The other method of damaging the choroid

capillaries by heat is to focus a very strong light through the pupil on to the pigments of the epithelium (a single layer of heavily pigmented cells lying between the choroid and the retina) and the choroid (Fig. 6). The focussed strong light energy gets concentrated on the dark pigment, which absorbs it to produce intense local heat damaging the choroidal capillaries in the vicinity. The process is known as 'photocoagulation' and is similar to the way children burn paper by focussing sun rays by means of a thick convex lens. The cornea and the lens act as the focussing system and a strong artificial source such as a xenon arc or a laser system replaces the sun as the source of light energy. However, photocoagulation is not effective in the presence of a detached retina. Therefore, it is usually used to seal a tear and prevent detachment. Photocoagulation is rerely used as a part of surgery of retinal detachments.

Cryopexy. The choroid capillarie can also be damaged by freezing Ice crystals are formed inside th cells lining the capillaries. Whe water (the cell content is 98 % water turns into ice it expands in volum and breaks the cell wall. The capi laries produce an exudate as i diathermy and photocoagulation The freezing is done by th cryopencil applied to th on surface of "globe (Fi the 7.) The tip temperature of the cryc probe is lowered to as low as - 70° (body temperature + 37 'C). The ti sue in contact cools rapidly and ult mately gets frozen This metho is new and has many advantage Unlike diathermy, the freezing doc not damage the sclera or the vitreou It can even be used through the cor junctiva without damaging it structure.

Scleral buckle. Buckles are produced by burying a material (a implant) of suitable size and shape if the layers of the sclera (intra-sclera

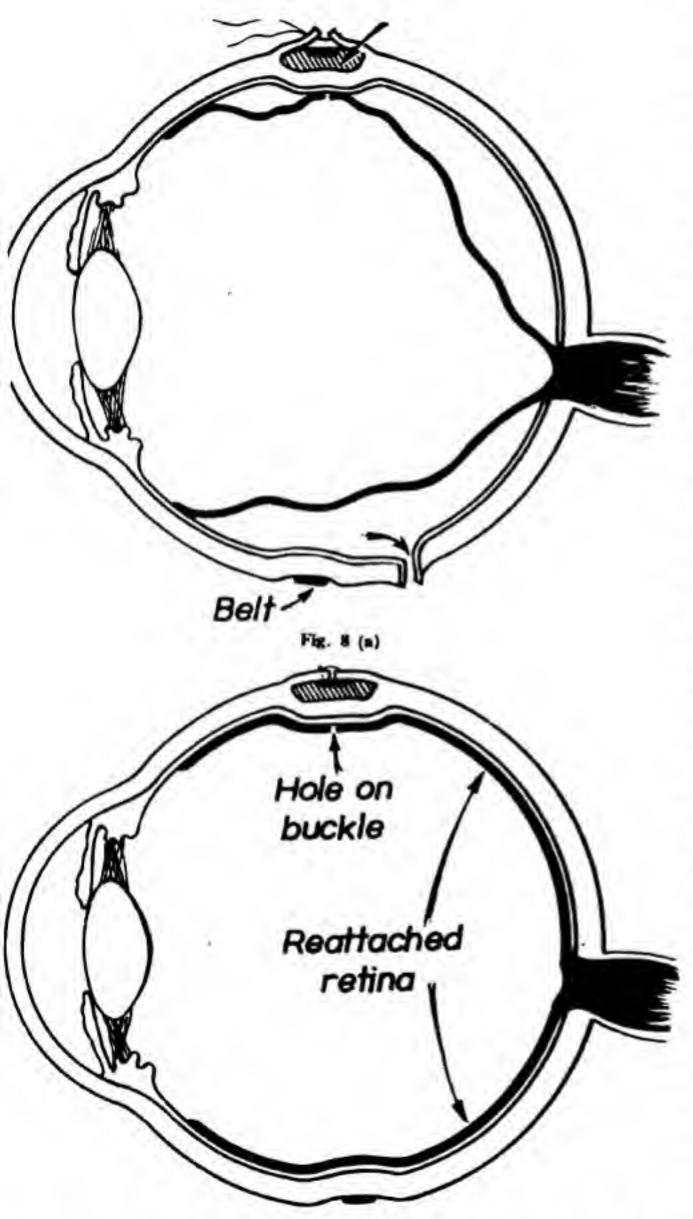


Fig. 8. (b)

uckle) or by suturing the implant n the surface of the sclera (epicleral buckle). When a more proninent and a permanent buckle is esired, an encircling band or string a passed all round the globe over the implants and is tightened to

contract the globe all round (Fig. 8).

Various materials have been used as implants. Silicon rubber or sponge is the most popular among non-absorbable materials.

Removal of the subretinal fluid.

If a patient with retinal detach-

ment is made to lie down flat or his back with both eyes bandaged there is a good chance that the sub retinal fluid will disappear resulting in a reattachment of the retina The vision will improve. In fact before Gonin, patients were kept or their back for years. However if the retinal tears are not clo sed, the retinal detachment is sure to recur as soon as the patient move about. Occasionally, when the reuna settles completely on bed rest the retinal tears can be sealed by photocoagulation alone and a surgery becomes unnecessary.

In the majority, however, the subretinal fluid has to be drained out during the surgical operation. A tiny cut is made on the sclera to expose the choroid. It is then punctured with a finely pointed instrument to drain the sub-retinal fluid (Fig. 8). Alternatively, the sclera and the choroid are perforated by a needle connected to the diathermy (+ ve) or catholysis (-ve) current. The procedure of draining the fluid could be risky. There is yet another technique where a choroidal reaction is produced by diathermy or cryopexy over the retinal tears, scleral buckles are produced, but no attempt is made to drain the subretinal fluid. In a few days the subretinal fluid disappears and the retina settles.

Routine use of indirect ophthalmoscope (Fig. 9) (an instrument to visualise the retina) during preoperative examination and during operation is perhaps the most important single factor in success o detachment operations. For ins tance, the success rate in detachmen operations at the Irwin Hospita before 1969 was less than 25% Ophthalmic surgeons with n special training used direct oph thalmoscopes completely inade quate instruments for retinal work However, since then, the routine us of indirect ophthalmoscope by th retina surgeons of the Retina Car Unit of Irwin hospital has resulted i success rate of over 75% in recent years. With improved operation theatre conditions and availability of specialised material for operation, the success rate could be improved even further.

That the eye surgeons trained in the old English schools are usually poor retina surgeons is just being recognised at a terrible cost to the detachment patients in Unfortunately, however, there are only a handful of ophthalmic centers n India which are equipped for retinal work. What is even more infortunate is that even in those few centers there are not enough retina specialists. There are a few ophthalmic surgeons in private practice in the large cities who have taken to retinal surgery in right earnest. They are a welcome addition to the extremely small group of retina specialists working in public nstitutions.

While lack of trained retina surgeons is the most pressing problem before the country today, there are the following factors which must be attended to:

Popularisation of indirect ophthalmoscopes among post-graduate students of ophthalmology.

Indigenous manufacture of such basic equipments as diathermy machines, cryo units, indirect ophthalmoscopes and later photocoagulators and vitreous-surgery equipment.

Until a decade back, most cases of retinal detachments were going blind undiagnosed in India. There were only a few centers where half hearted attempts were made and luck counted more than the skill and technique of the surgeons.

Now that modern detachment surgery is possible in the country, all out effort to train more ophthalmic surgeons in retinal surgery should be made. In the mean time patient of retinal detachment must be save from ophthalmic surgeons who as really no retina surgeons.

(To be concluded

Further reading

- Cibis, A. Paul (1965), Vitree Retinal Pathology and Surger in Retinal Detachment, Mosb Co., St. Louis.
- Custodis, E. (1960), Importance of Vitreous body in Retinal Surger with Special Reference to Reoperation, p. 175, Mosby Co., St. Louis
- Duke Elder S. (1967), System of Opthalmology (Vol. X), Henry Kimpton, London.
- Patnaik, B. and Kalsi, R. (1974)
 Retinal detachment—An analysis of 100 consecutive cases of retinal detachment, Ind. J. Opth. 22:25.
- Patnaik, B. and Kalsi, R. (1976)
 Dry detachment surgery, Proc VI. Afro-Asian Congress of Opthal mology (In Press).

PULSATING STARS (Continued from page 477)

ute magnitude is the average of the orightest and faintest magnitudes of pulsating star. In 1952, the entire raph was recasted by W. Baade of Mount Palomer. He found three eparate period-luminousity curves which previously were thought to be one: one for Clessical Cepheids, nother for Type-two Cepheids and till another for R.R. Lyrae stars Fig. 4). This discrepancy brought n an average error of 1.5 magnitudes n measuring Classical Cepheids' rightness. The rectification of the rror led to the doubling of the size f the universe.

As Cepheid variables are of high uminosity, they are useful in the neasurement of distances of nearer alaxies. The R.R. Lyrae, the less uminous ones having same absolute nagnitude, are useful as distance adicators for objects in our galaxy

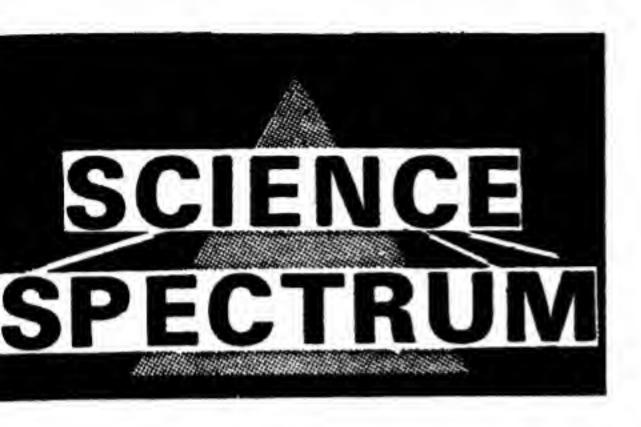
only. By the use of these stars Prof. Shapley surveyed the distances of clusters and nebulae. Knowing their directions he established the dimenstion of our galaxy and pointed out the eccentric but correct position of the sun which was then not believed. In 1924, Erwin Hubble, Mount Wilson Observatory, taking the help of Cepheid variables in Andromeda galaxy convinced the astronomers of the existence of galaxies as independent systems. How significant a role pulsating stars have played in the study of the universe can now be gauged.

Conclusion

Of whatever value the pulsating stars have proved to be in probing the depth of the universe, how much we have understood the pulsating stars is doubtful. Why are there are a few non-pulsating stars present in the pulsating region of the H.R. diagram? What makes certain stars pulsate when the effective surface temperatures are faithigher than the limit we have theore tically laid down. Just a few, isn't it? But they are highly controversial ones.

Further reading

- Percy, John R., Pulsating Stars Scientific American, 232, 6.
- Glasby, John S., Intrinsic Variables, Variable stars (1968), Constable, London.
- Smart, W.M., Delta Cephei—a pulsating star, Some Famous Stars, Longmans, Green & Co., London.
- Campbell, Leon and Jacchia, Luigi, The Story of Variable Stars, The Blackistan Company, Philadelphia.



Television detector cars

THE perfection of television among all electronic appliances is one f the marvels of scientific age. With he advent of TV (tele=far, vision= o see), electronics has made 'seeing t a distance' possible, and has dded a new dimension to broadasting. In India, the development of TV as a vital audio-visual media as been slow. However, in cities ike Delhi, Bombay, Calcutta, etc., ind adjoining towns within a radius of about 80 km, antennas on the oofs and terraces is a common sight. n recent years TV viewing has ained significant importance and denand for TVs is rapidly increasing. n the coming years, with the introuction of a second TV channel, here would be a further rise in umber of TV users -some without ny legal permit. So the licensing auhorities are bound to feel concerned nd therefore need reliable detection echniques to check and pickout the ffenders.

At a television transmitting station, n electronic camera converts TV ignals into a series of radio freuency electrical impulses. The freuency of the impulses corresponds that of radio waves. Further, they are amplified and fed into the transmitting aerial. The aerial radiates
electromagnetic radio waves which
are capable of travelling through
space over long distances. At a
distant TV, these waves are picked up
by an aerial. The waves induce pulsating currents in the aerial that are
identical with the original signal.
These electrical signals are fed into
the TV set, where they are amplified and converted into light to
reproduce the original sound and
picture on the screen of a C.R.T.
(Cathode Ray Tube).

Reliable and good reception in a TV set depends on the ability of its receiving aerial. "Good absorbers are good radiators" is a well-known fact. It is obvious that TV receivers are good transmitters of radio waves. If the dial of a sensitive radio set is adjusted in the neighbourhood of a TV set, a number of whistles are heard due to stray and spurious electrical disturbances. It is on this principle that a TV detector works. In a television set, a number of conductors or electronic circuits feed coils with alternating currents, so that each of the coils acts as a source of fluctuating magnetic field. Owing

to the back and forth movement of electrons in alternating current, the fluctuating magnetic field gives rise to electromagnetic waves. These waves induce undesirable current pulses in the neighbouring conductor of the receiving set, which can be picked up and eventually detected.

A refined detection technique b the use of detector vans and portable sets has been developed in U.K. which will help the licensing author rity to pickout the offender. The equipment has now been developed to such a degree of refinement tha exact location of the room, or flats in a large block, in which TV set i being used can be determined. The detector car carries at its top as aerial which is capable of rotating to pick up waves of high frequency These waves are radiated due to fluctuations in the magnetic field around the local oscillator coil o the frequency changer in a TV set The signals received by rotating aeria are fed to a sensitive radio receive in the detector van. The receiver in turn, feeds the signals to the ampli fier circuit attached to a C.R.T.

When the aerial points toward any television set in operation in it vicinity, a "blip" is observed on th screen of C.R.T. Its position ma be adjusted by slowly rotating it til maximum size of the blip is obtained In order to identify the building ac curately, a periscope is coupled to the aerial and moves along it. O looking through the periscope, th suspected building may be locate from the direction to which the aeria is pointing, provided, of course, that the TV set is in operation when th detector van passes through it neighbourhood. Such sensitiv equipment to find exact pos tion of a TV set in operation are quite popular in Britain. I India also they may soon be re quired.

> Department of Physic Regional College of Education Bhubaneswar (Orisse

Lymphocytes—the cellular basis of immune response

A LL animals are endowed with A an excellent defence mechanism which protects them from invading gents of the environment. The study of this defence mechanism has given birth to a very exciting cience known as "Immunology". The science of immunology deals with the specific responses which n animal shows when foreign mateials (antigens) are introduced into is body. Such immune responses onsist of synthesis of specific immuoglobulin protein molecules (antiodies) and/or specifically reactive ells (lymphocytes), both of which an circulate in the blood stream and react specifically with the antien. As a result of this immune eaction the foreign material may be nactivated, killed or engulfed by the ells of the reticulo-endothelial ystem. Under severe condition ypersensitivity reactions (e.g., allrgy) may also occur with the release f histamine and other pharmacoogical mediators of inflammation. n general, immune responses may e divided into two classes-humoal, and cell-mediated immune resonse. The immune response brought about by serum (circulating ntibodies) is called humoral imnune response, whereas those brought about by sensitised cells (lymhocytes) are called cell-mediated nmune responses. The present rticle discusses how lymphocytes cell-mediated immune tididx sponses.

The history of immunology dates ack to 1798 when it was discovered nat milkmaids were immune to mallpox infection. In those days, and even upto the first half of the oth century, immunology was a field

for those who were primarily interested in infectious diseases, allergies, and the question how antibodies are made. The 1950s and the early 1960s saw the exploration of the chemical basis of antigen-antibody interaction and the molecular basis of antibody structure. Many immunologists were convinced that in order to understand how antibodies work, there was an imperative need to know how immunoglobulins (antibodies) look like. Molecular biologists had to know what DNA looks like before they could begin to understand the gene function.

Lymphocytes and immunity

Lymphocytes or white blood cells are one of the important constituents of blood. The total lymphoid tissue of a normal mammal constituets about 1% of its body weight. Its predominant cellular component is the small lymphocytes. These cells are ubiquitous throughout the body but concentrate in lymph nodes, thymus, spleen, bone marrow, the blood stream, fluid of the peritoneal cavity and the major lymph channels. The immune system which is quite impartial in its dealing with foreign materials consists of lymphocytes and the antibody molecules they secrete.

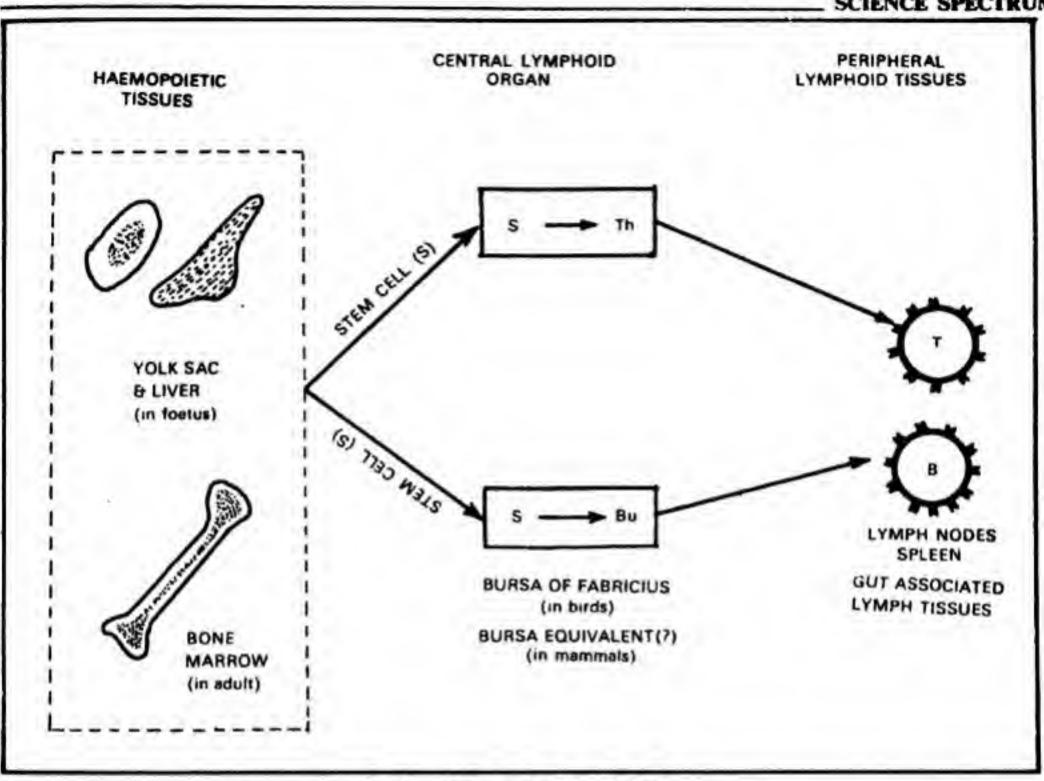
In the past it was thought that lymphocytes had nothing to do with the immune system. It all began during early 1960s when cellular immunologists demonstrated that lymphocytes were the principal cells involved in immune reactions. The most convincing evidence came from irradiated rats. Irradiation killed lymphocytes and the rats showed no immune reaction. When a pure population of rat lymphocytes,

obtained from the chief lymphat vessel (the thoracic duct), was give to irradiated rats, both cellular and humoral immunity were restored. I addition, depleting the animals of lymphocytes by prolonged drainage of the thoracic duct was found to impair their immune responsiveness. The lymphocytes, whose origin and functions had been a mystery follong, were established as "immune competent" cells.

The central dogma of immunology

Although lymphocytes appear to be a homogenous population, the are actually a heterogeneous collection having different fates, function and origins. There are two distinc types of "immunocompetent" lym phocytes; one which requires the thymus gland for development and is responsible for cell-mediated immu nity, and another which develop independently of the thymus and mediates humoral antibody response In this way, the "two-lymphocyte model" of immunity was established at least in case of birds and mammals with two major lymphoid organs—(a the bursa of fabricius (a cloaca lymphoid organ unique to birds) or its mammalian equivalent (still unknown), and (b) the thymus. The lymphocytes derived from thymus are referred to as "T cells", while those derived from the bursa in birds or its equivalent in mammals are called "B cells".

All the lymphocytes that circulate in the tissue arise from precursor cells in the bone marrow. About half of these lymphocytes, the T cells, pass through the thymus on their way to the different organs of the body. The other half, the B cells, go directly into circulation. This "dichotomy" which works with the two types of the lymphocytes was first discovered in 1968 by Henry N. Claman of University of Colorado Medical School, U.S.A., and was



haracterized by Jacques F.A.P. tiller and Graham Mitchell of the asel Institute for Immunology, witzerland. The dichotomy of the nmune system into T and B lymphoytes has become what is presently nown as the central dogma of nmunology.

discovery of T and B cells

The chicken has played a leading ole in the discovery of the two ompartment system of immunity. Glick of the Ohio State Univerity was working on the effect f removal oi an organ called ne bursa of fabricius (in chickens, he bursa is-a lymphoid organ cated at the posterior end of the astrointestinal tract) from chicks order to check the assumption that plays some role in sexual develop-

Fig. 1. Development of T and B cells

ment. Once, one of his colleagues borrowed some of his bursectomized chickens (chickens in which bursa was removed) to demonstrate the features of antibody production to a group of students. It was found that the operated birds showed poor antibody production. Glick therefore reported in 1956 his observation in Poultry Science after Science turned down his paper on the ground that it was not of general interest. Such an important observation thus remained in the realm of poultry physiology for several years. It was only in 1967 that R.A. Good, the present director of the Sloan-Kettering Institute for Cancer Research, New York, heard about this crucial observation. Good with his active group started these investigations only to find that each of the organ (the bursa and

thymus) is responsible for producing distinct "immunocompetent" cells the T and B cells. Also, during th N. Warner and hi same time the University o colleagues at Melbourne, Australia, came forward with the idea that the immune system is dissociated and is controlled in part by the bursa and the thymus In this way, it was learnt that 7 cells pass through the thymus when they differentiate and mature into competent lymphocytes; the B cell mature into immunoglobulin-produc ing plasma cells (antibody-producing cells).

Development of T and B cells

Experiments with chicken and mice have clearly established that hacmopoietic (blood forming) stem cells from foetal yolk sac and liver migrate to the thymus and then proliferate into T lymphocytes under the inductive influence of thymic hormones. In adult animals, the stem cells from the bone marrow migrate to the thymus (which can be hardly identified), but the rate is very slow in comparison to that of fetus and newborn. The overall process of the development of T cells may be visualized as:

stem cell→thymocytes-→mature thymus lymphocyte→peripheral T ymphocytes (Fig. 1).

Properties and functions of T and B cells

Although T and B cell populations are heterogeneous, T cells have a onger life span, on the average are lightly larger, more dense, less adherent to glass, plastic and nylon, etc., and more negatively charged than B cells. Furthermore, T cells are electively depleted by anti-lymphotyte serum (antibody preparation against lymphocytes), but in general are less sensitive to drugs such as cyclophosphamide, corticosteroid,

and irradiation.

The B lymphocytes are the cells responsible for the production of antibodies. But what makes B lymphocytes to produce antibodies? Most lymphocytes do not actually secrete antibodies. They are 'small' lymphocytes and are said to be in a resting state, but each of the cell is committed in advance to the production of one specific antibody. In order to secrete antibody, the cells must first be activated by an appropriate antigen.

One would agree that the understanding of the two-compartment system of immunity, as it stands today, has paved the way to a better immune mechanism in human health and disease. Based on this knowledge, rational attempts are presently being made for the benefit of patients with autoimmune disease, cancer, infections and organ grafts.

SANDIP N. SINHA
DIPAK K. DUBE
Department of Biochemistry
University College of Science
Calcutta University

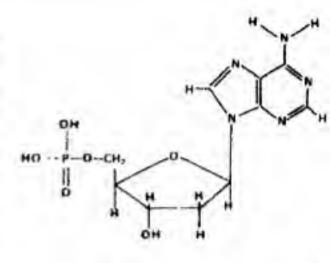


Fig. 1 (a).

A nucleotide itself is a comple structure composed of an organi base, a deoxyribose sugar and . phosphate group. There are fou organic bases, namely, adenine (A) guanine (G), cytosine (C) and thymin (T) present in a double helix. Th first two bases are purines and th last two pyrimidines. The purines and pyrimidines are nitrogen-contain ing closed ring organic compounds The two strands of DNA arr related to each other. For every A in on strand, there is T in the other, and for every G there is C in the other. The bases, A and T and

Improvements in gene isolation techniques

ENETIC information is transmitted from parents to offsorings through units called genes. J.W. Beadle and E.L. Tatum of California Institute of Technology, J.S.A, as late as 1930s demonstrated hat this is as true of microorganisms s of complex organisms. It was hen apparent that the principal funcion of the genes was to give infornation required for the construction f proteins. The experiment conucted by F Griffith, an English acteriologist, in 1927 gave clear vidence that the genes of bacteria re made up of deoxyribonucleic cid (DNA). That the virus genes re made up of DNA was proved by

A.D. Hershey and M. Chase at the Carnegie Institution in Cold Spring Harbor, New York. A number of viruses however contain no DNA but are composed of RNA and protein only. Examples are poliomyelitis virus, influenza virus, tobacco mosaic virus, etc. It is now quite certain that the genes of higher organisms are composed solely of DNA.

DNA structure. DNA is a long, double-stranded macromolecule. The strands are coiled helically around each other forming a double helix. Fach strand is made up of a chain of four kinds of nucleotides.

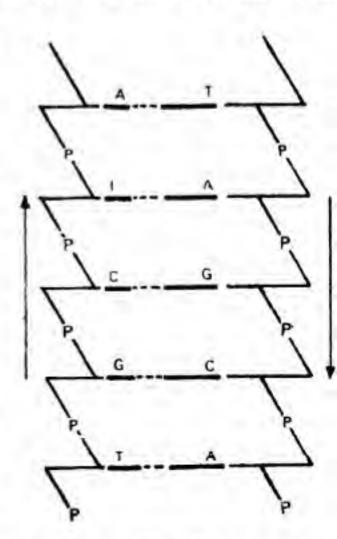


Fig. 1 (b). Samplified diagram of a very short double bells to show the specific complementary base-pairing

3 and C, are "complimentary sases" and so are the two DNA trands. This is called the complinentary base pairing. The complinentary bases are associated with ach other by a chemical bond known is hydrogen bond. The sugar phoshate "back-bone" of the DNA trands are wound around one nother to form a double helix. The outlines of the structure that have been described so far are given by J.D. Watson and F.H.C. Crick of Cavendish Physical Laboratory, Cambridge University, Cambridge Fig. 1).

Gene. Genes of all organisms are nade solely of DNA, with excepion of a few organisms in which hey are made of RNA. DNA herefore is regarded as the primary torehouse of genetic information. The discrete segments of DNA which ontain genetic information are nown as genes. However, all genes re different as regards the number nd combinations of four nucleoides. Each gene determines the tructure of another acid known as ibonucleic acid (RNA). In living ells only one strand of DNA serves s a template along which the nucleoides are lined up according to the omplementary rules to form RNA. pecifically, the formation of mesenger RNA (mRNA) from DNA is alled "transcription", and the fornation of protein from mRNA is alled "translation".

RNA structure. RNA is a polymer hat is chemically similar to DNA. lowever, there are three differences etween these two acids. First, most NA molecules have only one rand. Certain froms of viral RNA re an important exception to this eneralisation. Secondly, RNA has ree bases similar to those of DNA, amely, A, G and C, but the fourth ase T is replaced by U (Uracil). astly, the sugar molecule is ribose stead of deoxyribose. Ribonucleic

ADENINE components of which DNA is made. Also the structure of one strand of DNA

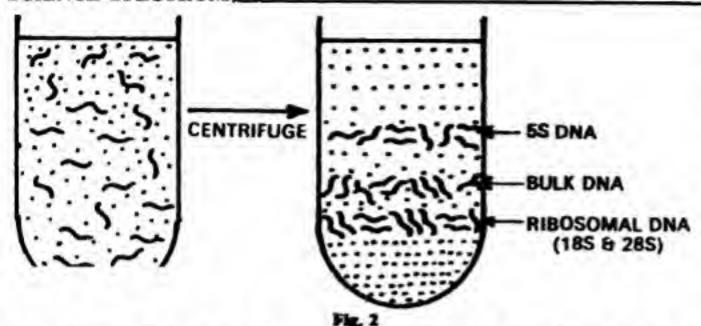
Fig. 1(c). The structure of chemical

acids are classified into three types according to their metabolic roles. The three classes are: (1) messenger RNA (mRNA), (2) transfer RNA (tRNA), and (3) ribosomal RNA (rRNA).

The sequence of nucleotides in messenger RNA determines the scquence of amino acids to be incorporated in a new protein molecule (translation). Transfer RNA molecules are smallest occurring ribonucleic acids made up of about 18 nucleotides. They play a role in protein biosynthesis. The role of ribosomal RNA is structural. It forms a sort of skeleton for the

assembly of ribosomes during protein synthesis.

Ribosomes Ribosome structure. are cellular particles mostly present in the cytoplasm. They are spherical in shape. Ribosomes are the sites at which protein biosynthesis occurs and are therefore rightly regarded as "miniature factories" for making protein. The ribosomes and some of their components are commonly referred to by their S-value (S-stands for Svedberg units, which are a measure of the speed with which a molecule sediments when subjected to a centrifugal force). S-value are approximate values of the sedi-



mentation coefficients as measured in the ultra centrifuge and expressed in Svedberg units. Ribosomes themselves are 70S in lower organisms and 80S in higher organisms. Their properties are dependent upon the magnesium ion concentration. If the magnesium ion concentration is lowered, they dissociate into two constituent sub-units. The sub-units sediment at 50S and 30S for the lower organisms, and 60S and 40S for the higher organisms. The larger sub-unit is almost twice the size of the smaller.

Ribosomes account for a considerable proportion of RNA. About 80% of the RNA in a cell is in the ribosomes. Each bacterial ribosome contains about 50% protein and 50% RNA, while ribosomes of chromosomal organisms or higher organisms contain about 60% protein and 40% RNA rRNA is present in abundance and, therefore, can be easily identified. Each ribosome contains three kinds of ribosomal RNA molecules. They are in different sizes and can be easily purified. In E. coli, they are 23S, 6S and 5S. In the African clawed-toad, Xenopus, there are 28S, 8S and 5S molecules. These three nolecules can also be recognised by the different molecular weights apressed in daltons. Ribosomes ave an affinity for mRNA, and also or tRNA.

The discrete segments of DNA etermine the structure of RNA. pecifically, DNA that codes for

ribosomal DNA (rDNA). The base sequence in the rDNA is characteristically different from the the rest of the DNA. It has a high content of guanine and cytosine bases that make its isolation possible. For gene isolation the investigator makes use of density-gradient centrifugation and RNA: DNA hybridisation experiments.

Density-gradient centrifugation. It is a primary technique for the fractionation of DNA. It separates DNA molecules on the basis of differences in their densities. DNA molecules with different G-C contents have different densities. The greater the G-C contents, the higher the density of DNA. The DNA to be fractionated is mixed with caesium chloride salt in a centrifuge tube and spun at a speed of 30,000 to 40,000 revolutions per minute. The caesium salt begins to sediment due to the strong centrifugal force, forming a concentration gradient in the centrifuge tube. Each molecule of DNA starts moving to a level in the salt gradient at which the salt concentration exactly equals the molecule's density (Fig. 2). In this way, a mixture of DNA with different base composition is separated into discrete bands of DNA at different levels in the salt gradients. (For complete demonstration of caesium chloride density-gradient centrifugation see S.R. Jan., 1975, page 21).

RNA:DNA hybridisation. The complementarity of bases helps

determine just how much sample DNA is a gene or genes for a specific RNA. First, the tw strands of DNA double helix are s parated by heating at 100°C an then rapidly cooling to 0°C. Cooling is achieved by plunging the DNA containing tube into a freezing mix ture. Strand separation can als be achieved by adding NaOl and then HCL. This process known as 'DNA denaturation The DNA is immobilised by fixing on a piece of filter paper with th help of formaldehyde. Fixation of the separated DNA strands is neces sary so that they cannot come bac to form a double helix. To this solution, containing radioactive RNA which has heavy phosphorous atoms is added. The radioactive RNA i known as labelled RNA.

The DNA and labelled RNA are allowed to interact with each other in the proper salt solution at the correc Sufficient time i temperature. given for the RNA molecule to fine a complementary strand of DNA and pair with it to form a stable RNA: DNA hybrid molecule. This hybrid has one strand each of RNA and DNA. The RNA which does not hybridise with DNA is degraded with an enzyme called ribonuclease and the fragments of RNA are washed off. Ribonuclease has relatively no effect on DNA and the

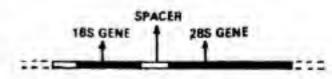


Fig. 3. Ribosomal DNA of Xenopus base on chemical electron-micrograp data

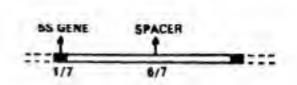


Fig. 4. Ribosomal DNA which code for 50 RNA. Spacer is much longer in this case (X. laevis).

ybrid molecule. The next step to measure the radioactivity of he labelled RNA on the filter paper. The amount of radioactivity shows ow much of the RNA is bound to NA. This shows how much of the DNA has a nucleotide sequence to common with the RNA sequence. That particular nucleotide sequence of the DNA is assumed to be the general regenes for the RNA.

This assay system makes it posble to count the number of copies f a gene (known as gene multiplity) that exist in the complete DNA. is also possible to compare the NAs made in two different organs r in different species and find out they contain identical sequences. Gene isolation. H. Wallace and 1.L. Birnstiel of the University of dinburgh in 1966 found through ensity gradient centrifugation and NA: DNA hybridisation experinents, that the genes for 18S nd 28S ribosomal RNA are denser nan the bulk of the cell's DNA. David Brown and others at the arnegie Institution of Washington absequently found that the genes oding for 5S are lighter than the nain band DNA, as the genes themelves are very small.

These experiments established that wo of the three kinds of RNA 18S and 28S) are encoded by genes hat have the same density, because hey band together in caesium choride. Therefore they must be on he same molecule known as ribosonal DNA. However, the genes for S RNA which have different densiies are on other DNA molecules. and others could Brown David lso estimate the number of ach kind of gene in a single set of hromosomes. There are about 450 opies each of the 18S and 28S enes and about 24,000 of the 5S enes in each set of Xenojus chronosomes. Since diploids have two ets of chromosomes, each cell must contain twice the number of genes.

The genes, coding for ribosomal RNA have been isolated from the DNA of the two related amphibians Xenopus laevis and Xenopus mulleri. Three characteristics of the ribosomal genes made them appropriate candidates for isolation. First, the availability of the homogeneous RNA that could be radioactively labelled; secondly, the physical differences between ribosomal genes and rest of the DNA, and lastly, the presence of the genes in multiple copies.

The first small amount of Xenopus laevis rDNA was isolated in 1967
by M.C. Birnstiel and his colleagues
at the University of Edinburgg. They
did it by centrifuging Xenopus DNA
repeatedly in a caesium chloride
gradient, each time collecting only
the densest fractions and following
the same experiments of RNA:DNA
hybridisation and radioactivity
measurement.

The centrifugation method has been improved since 1967. There have been several other advances in the technique; an easy method developed by Mare Leng and Gary Felsenfeld of the National Institute of Health (U.S.A.) is that of polylysine. Polylysine is the synthetic polymer of the amino acid L-lysine. It tends to bind to DNA lengths that are high in A and T, leaving intact DNA lengths that are high in G and C. Binding causes the precipitation of that length. This selective precipitation of the DNA molecule helps in the differentiation of high A and T from the high G and C DNA lengths. If carefully applied, the polylysine technique can precipitate 99 % of the total Xenopus DNA leaving in solution the ribosomal DNA.

These advances in the techniques and several kinds of experiments including electron microscopy and chemical analysis have given a rather detailed picture of the DNA that governs the synthesis of 18S

and 28S RNA molecules (Fig.3). Th ribosomal DNA consists of a serie of repeating units which include three major sequences: a gene for 18S RNA, a gene for the 28S RN and a spacer sequence. 18S an 28S genes are transcribed into RN. as usual but the spacer region is no transcribed into RNA. The fund tion of the spacer region is no known. The ribosomal genes hav at least some nucleotide sequence in common in the cells of mor than 50 organisms including mam mals, vertebrates, higher plants, pro tozoa, fungi and yeasts.

George Brownlee and Frederic Sanger of the University of Cambridge (1965) have suggested that the SS RNA component is small enough Recently, Donald Brown and his colleagues have purified the St DNA from both X. laevis and X mulleri cells by density gradient centrifugation and RNA hybridisation (Fig. 4).

This indicates that one-seventh of the DNA is the gene for 5S and remaining six-sevenths of the DNA consists of spacer sequences. Similar experiments with purified 5S DNA from X. mulleri have shown that only about one-eighteenth of the DNA molecule encodes for 5S RNA Since the RNA molecule is of the same size in both animals, the difference must be due to a much large spacer region.

It is hoped that many genes with a variety of other functions could also be isolated. This would be possible with the development of more sophisticated methods. With their purification, it will be possible to analyse their structure and chromosomal location. Then the control mechanisms that regulate generation would be clearer.

SUBHASH AROR G.S. KALR

Institute of Advanced Studie
Meerut Universit

Bionics—the science that copies from nature

OST of us are familiar with the word electronics and with the most magical performances of lectrons in thermionic valves, transtors, cathode ray oscillographs, elevision and thousand other appances of everyday use. But, perhaps, nany of us have not heard of biolics—a new, fascinating and promising branch of science. It is still in its infancy.

Bionics is a combined abbreviation or biology and electronics. It studies he electrical processes and the role of electrons in biological systems to pply them to the construction of imilar mechanical systems.

The word bionics was coined by Aajor J.I. Steel of the Aeronautical pace Development Department of J.S.A.F. He defined bionics as he branch of science which deals ith such systems which work like ving systems or systems resembling hem. As a matter of fact bionics is he study of living systems found in ature for such clues as can be helpul in developing electronic devices hat can see, hear and then interpret that they see and hear. Bionics ims at copying nature, but it is astly more difficult to copy nature han to control it.

The first bionics convention held in 960 was attended by 600 scientists onsisting of mathematicians, engineers and physicists. The next convention held in 1963 was attended by 000 scientists. At this convention model of the frog's eye containing 600 light sensitive artificial cells and lso an electronic muscle booster were demonstrated. When a spaceraft undergoes very high upward celeration the weight of the space-

man increases and his limbs become so heavy that he finds if difficult to move them. The electronic booster comes to his rescue. The bio-electrical signal from the brain, ordering a limb to move, is conveyed from the limb to the booster, which instantaneously operates to help the limb move itself.

The network of nerves in most living creatures is a splendid organisation for handling different kinds of information which arrive from different sources. The 'neuron' is the building block of the nervous system. The neuron is a basic microscopic electronic circuit elements of astonishing excellence. Nature has combined and arranged these basic elements in a vast array of perceptive, analytic, defensive and decision-making systems packaged neatly bewildering variety. example, bats, owls, spiders and porpoises, etc., carry ingenuous variations of sonar-like apparatus for steering themselves, and for communication and locating preys. Rattlesnakes possess an infrared heat detector of unmatched sensitivity for seeking preys at night. Pigeons and certain migratory birds have a small mechanism, a direction finder instrument indeed, that enables them to navigate unerringly over long distances. The eyes and the mind of the frog are combined in a single effective system that screens out all details except those that are needed to catch an insect or ward off an enemy. The insignificant cockroach can detect movements of less than one millionth of an inch. The fly possesses a gyroscope which enables him to keep flying in a straight line

at a constant height.

So far as the collection of information is concerned, the researched is looking with inquisitive eyes at the hereditary blueprint to be found in the gene which contains per un volume vastly greater information than that contained in the brain.

The cells of the living eye not only detect and transmit to the brain the light signals they receive but also select and analyse the signals before transmitting them to the brain. It is believed by bionicists that by impacting the mechanism of its working better radar transmitters and detectors could be constructed.

The human ear has evolved from a simple hearing system to a ver efficient sound detecting system. The study of the complicated auditor system at Radio Corporation of America is leading towards the construction of electronic for computer machines which can enable the atto take dictation, obey or a orders and translate from one language to another. A typewrite which can type by dictation has already been fabricated.

By studying the eye of the crab scientists have been able to constru ct a television camera which repro duces pictures very faithfully. Stud of the bee has led to the develop ment of better ground speed indicato and a better distance indicator. Fo designing better aircraft wings aero nautical engineers have always been guided by the shape and curvatur of the wings of certain birds. Scien tists are studying the gills of fishe to design breathing devices for diver and underwater swimmers. The salmon fish is being studied to under stand the mechanism of the olfactory system. The dolphin can swim a an astounding speed which is believed to be due to a frictionless coating or his skin. Attempts have been suc cessfully made to prepare a rubbery paste which when smeared on the uter surfaces of sea and river craft educes the viscous drag of water. For underwater communication the olphin uses ultrasonic sound. Their technique is being copied for inderwater communication between uman beings.

Some researchers believe that the novements of the muscular system of the superior to the novements of the parts of a big nachinery. Machines designed and onstructed by copying the muscular systems of living beings are called cybernetic Anthropomorphic Machines or C.A.M. in short. A C.A.M. esigned in this way can travel with a speed of 55 km per hour with the help of mechanical legs on unven terrain.

Workers in the field of bionics re also trying to find out the mehanism by which the eel fish can enerate electricity of hundred volts of give a stunning shock to its energy, and also the mechanism by which the firefly emits cold light. They are also trying to understand the mechanism by which living creatures can transform their fuel or cold into energy. This will lead to the evolution of the bio-electric enerator.

All biological processes in plants nd animals are basically electrical nd electrochemical processes inolving movement of electrons, heapig up of electrons, chemical changes duced by moving electrons or moveent of electrons initiated by chemial changes. The whole nervous sysm, including the brain, forms a very omplex electronic circuit containing illions of circuit units each of these nits is a 'neuron'. These units are ke switches which are either open r closed and any one of these swithes may at one moment be conneced to more than hundred such witches. All signals are transmitd through this system in terms of wo signals only, yes and no, cor-

responding to switch on and off. Computers use the same binary code and they do all the complicated calculations using only two numbers 0 and 1. But in order that an electronic computer or a mechanical brain can perceive, learn and organise its own operation, it will have to use billions of such circuit elements just as nature uses billions of neurons for a similar job. If the thermionic valves were to be used in such circuit elements, the Empire State Building would be needed to house them and the waters of the Niagara falls to cool them. Fortunately transistors have come to the rescue of scientists from such an unsurmountable situation. Research and success in the field of miniaturisation of these circuit elements have been astonishing. The superconducting memory cells manufactured these days are so small that one billion of them may be contained in a space of one cubic foot. A computer logic element made in this way consists of a single piece of silicon so small as to pass through the eye of a needle. Printed electronic circuits prepared by sputtering method are so small that 20,000 such circuits could be contained in an area not larger than that of a postage stamp. Yet all this magnificient miniaturisation is insignificant when compared with the miniaturisation found in nature. The amount of information carried per unit volume of the hereditary blueprint of the gene far exceeds the information carried per unit volume of our brain cells.

Scientists working in the field of bionics have been able to evolve artificial neuron cells some of which are called aertrons, memisters, cybertrons, perceptrons, etc. They function very much in the same way as the corresponding specialised neurons in living nervous systems.

The speed at which the human



"Try to devise a method by which can also shed tears like a crocodile."

brain can work is much below the speed at which information must be received and analysed, decision takes and communicated, in order to con trol and guide the fast moving traffic at a modern busy airport or a busy highway. The reception, processing and analysis of weather report pouring in at a high speed by radio at a meteorological station, calls fo the same superhuman speed. Suc a speed is possible only for an electronic computer. In quest of spe cial purpose systems for dealing wit these problems a three pronge attack is being made.

Biologists are seeking essential clues in nature to know how an why living mechanisms function at they do. Chemists, physicists, an electronic engineers are compounding new materials, creating new versatifications that can endow electronic machines with abilities comparable to those of living systems. Mathematicians are exploring intricate by ways in search of logical patterns for organising new electronic machine.

PROF. M.N. VERM

Odour communication in man

M AMMALS in general are known to possess a good sense of smell. It is used for communicating sexual status, individual identiication and maternal attraction. speculations, whether such a communication between the members of nomo sepian species is possible, arise. There are glands in the human body which produce substances that serve is olfactory attractant to other nimals; dogs can recognise their nasters (or criminals) by smelling dours left on his articles. However we can only wonder if we can identify nother person and determine his or ner sex by odours. Besides, can an nfant identify his/her dour? We can expect a mother's odour arousing behavioural respoases in her infant such as sucking novements of mouth and crying.

Musky male, sweet female

Michael J. Russell of the Division of Chemical Pharmacology, Univerity of California, has reported in Vature (260, 5551, April 8, 1976) the esults of his experiments conducted on the above two lines of research. n the first experiment, some college tudents, both boys and girls, were given each a plain white T-shirt 50% polyester and 50% cotton) to vear for 24 hours as an undergarnent. They were asked to wash hem only with clean water for 24 nours prior to testing. Properly lesigned, the experiment did not llow any contamination. The Thirt of each individual was kept eparately in a wax-coated cardboard ce bucket and the buckets were rranged randomly. A triangular ole was made in each bucket with he under arm portion of T-shirt earing the hole.

In this two step experiment, the

subjects were asked to identify the subjects' own T-Shirt (i) (ii) a strange male thirt (iii) a strange female shirt. In the second test which followed within a few minutes of the first, volunteers were asked to differentiate between the same strange male and the same strange female shirts. The two step experiment provided highly significant results, in each case thirteen of the sixteen males and nine of the thirteen females answered correctly. However, though in both the tests the number of correct responses by male and female volunteers were the same, the individuals who answered correctly were not always the same. The volunteers also characterised the male odour as musky and female odour as sweet. Above studies show that at least rudimentary communication individual identification and sexual discrimination can be achieved by olfactory means.

Maternal attraction

In 1877, Charles Darwin reported that children of an early age group may use odours to identify their mothers. Some more workers also provided preliminary but conflicting evidence that infants may be attracted to the odour of their mothers' milk. In the second experiment, Russel therefore investigated, if mothers could

identify their infants (age 2 day 2 weeks and 6 weeks) for this purpos The mothers were asked to put white cotton sponge inside the brassieres for three hours before testing. They were also not allowe to feed their babies during this period Infants while asleep were then sub jected to the test. It can be said her that sleeping stage was the righ time for the experiment, otherwis infants would also show response to visual stimulus. It will be difficul to discriminate between the response as a result of two different stimuli olfactory and visual.

During the course of experiment infants were exposed to: (i) a mois clear pad, (ii) own mother's pad, and (iii) a strange mother's pad, all held one after the other in a randon fashion at a distance of 1 to 3 cm for 30 seconds. The investigation lead to some interesting observations For example, (i) among two day ok infant only one out of ten made a sucking response without discriminating between his own and strange mother, (ii) 2 week infants showed general response to both own and strange mother's without such discrimination and (iii) at 6 weeks of age, however, most of the infants responded to their own mother's odour with clear orientation and sucking responses. The above results suggest the existence of an olfactory maternal attraction in operation at a very early age of human beings.

ZAKA IMAM

Bajra causes ergot poisoning

B AJRA or pearl millet (Peninisetum typhoides) is grown in Northern India, Rajasthan, Gujarat and Maharashtra, where it forms a staple food of the poorer section of the people. Unlike other mycotoxic fungi which are 'storage fungi' (where fungus attacks the grain when it is stored for future use), ergot is a 'field fungi', i.e., infection of the plant occurs at the flowering stage. The fungus Claviceps fusiformis is a mem-

er of Ascomycetes. It infects the vary of the flower. Instead of normal healthy grain, the fungal hyphae roliferate in the female inflorescence earhead) of bajra and produce ark, spur-shaped sclerotia. The clerotia are compact tissue-like funal hyphae, with hard thickened ind, capable of remaining dormant or long periods during unfavourable onditions for growth of the fungus. These sclerotia are commonly known is ergot.

In India, ergot of bajra has been

ported since 1957, though infection not very severe. But recently high ielding varieties of bajra were introuced which are believed to be highly usceptible to the fungus. There are eports of ergot poisoning from Aharashtra and Rajasthan due to onsumption of ergot-infected bajra. In late 1975 an outbreak of ergot oisoning in humans was investigated y National Institute of Nutrition, lyderabad (ICMR. Bull. Vol. 6, lo 1). The survey revealed that ut of 14 households in 21 villages, 0 persons had suffered from poisonng. Acute symptoms appeared one r two hours after bajra meal has een eaten. Symptoms were nausea, omiting and giddiness followed by

rowsiness. The disease lasted for 4-28 hours but patients recovered ompletely. The disease was self-

miting and was not fatal.

Ergot poisoning is caused by toxins resent in the fungus. These toxins re alkaloids of the clavine group amely elymoclavine, chemoclavine, enniclavine, setoclavine, etc. But lkaloids of ergot of rye and wheat re different from these alkaloids as hey come from ergotamine-ergoto-in class. The toxic manifestation roduced by ergot of bajra are also ifferent from the ergot of whea and ye. But neurological effects prouced by ergot of all the three foodrains are similar.

The percentage of alkaloid present

in bajra which caused poisoning is 1.51 to 19.93 mg/100 gm of grain. The percentage varies from 20 mg to 20 mg/100 gm of grain.

Induced toxicity of ergot on animals produced drowsiness followed by hyperexcitation, redness of face, weakness and loss of sensation of thermal and tactile stimuli in hind limbs. This clearly shows the involvement of nervous system. Therefore, ergot contamination is important both from the point of view of public health and bajra production. Since it involves nervous system, it can cause serious discomfort in bajra eatin population.

Ergot is a field fungus and so the flowering time of crop is important in preventing the crop from infection. By deciding the correct sowing time chances of contamination can be reduced. The infecte grain can be weeded out by immersing the grain in salt water (disease bajra floats on the surface duto lightness). Disease resistance varieties should be sown as a preventive measure.

NISHA BAJPA

Unique frogs and snakes of India

THE forests and foot-hills of the Himalayas in the north and Western Ghats in the south-west India contain a rich and varied fauna of our country. In the midst of our ambitious 'Save Tiger Project' and

other attempts aimed at conserving the big and colourful inhabitants of our forests, we are apt to ignore the existence of the rarely seen but unique worm-like frogs called Caecilian and small snakes, namely, Uropelts



Fig. 1. The Himsiayan Caecilian, Ichthyophia alkkimensis, with its Note the display of parental care by an Indian frog

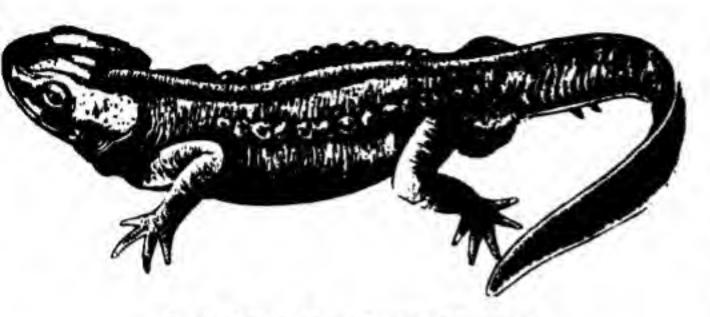


Fig. 2. The Indian newt (Tylototriton verrucosus)

Caecilians

Caecilians are slim, worm-like reatures confined to forests. They ire terrestrial and lead a concealed ife in damp earth. They are small n size, never exceeding 320 mm. in ength. They look like soft snakes or giant earth worms for which they ire always mistaken. Their eyes are very small. For a layman, it is ard to believe that the Caecilians re Amphibians as they are neither lose to frogs nor to salamanders, he lizard-like frogs. Because these reatures are small, secretive and imited in number, very little work on their distribution and ecology as been done so far.

If carefully searched for in damp orested areas, they may be found inder rocks, fallen tree trunks, decaying vegetation or even in mud. They an be recognised by their skin which is wrinkled, a short tail, and by the presence of minute eyes buried in the kin. Another point of identity is retractile tentacle present between the eye and the nostril.

iabits

Caecilians never attempt to bite if andled but they may exude a musky ecretion. On moist ground they an move quickly and are difficult a capture. The well known Indian caecilian Ichthyophis glutinosus is alled the sticky or slimy caecilian. But the fact is it is neither sticky nor

slimy and its identity as a frog can be established by the fact that its throat throbs constantly like a frog's.

They feed mainly upon earthworms and also on termites and other insects and small earth snakes occasionally. They are essentially solitary animals.

Classification

It is hitherto believed that the Indian Caecilians are known by only two species contained in a single genus (Ichthyophis). The present day Indian Caecilians are referable to as many as 15 species in 4 genera, viz., Ichthyophis, Indotyphlus, Uraeotyphlus and Gegeneophis.

The caecilians are poorly figure animals in the zoological books an hence they are completely unknow to nonbiologists.

Indian Newt

The forests in and around Darjeting and Eastern Himalayas are the centre for the sole representative of the fascinating lizard-like frog, Tyle totriton. Though the ecology of the species is also imperfectly known, is time effective steps are taken to protect this unique frog from destruction at the hands of specialists a well as the laymen.

Rough-tailed snakes

Few of us are aware of the existence of beautiful and harmless snake found under stones, in deep mudd soil and in decaying vegetation of the forests and foot-hills of the Western Ghats.

Commonly called rough-taile (Uropelts) because of their peculia tail which ends in a spiny shield, thes snakes are small, never exceeding a foot in length. Shying away from light, they lead concealed lives digging their way into the soft soil with the wedge shaped head. Obviously the



Fig. 3. The common rough-tailed make, Uropeltis pulneyensis, of Kodal Hills, Western Chats

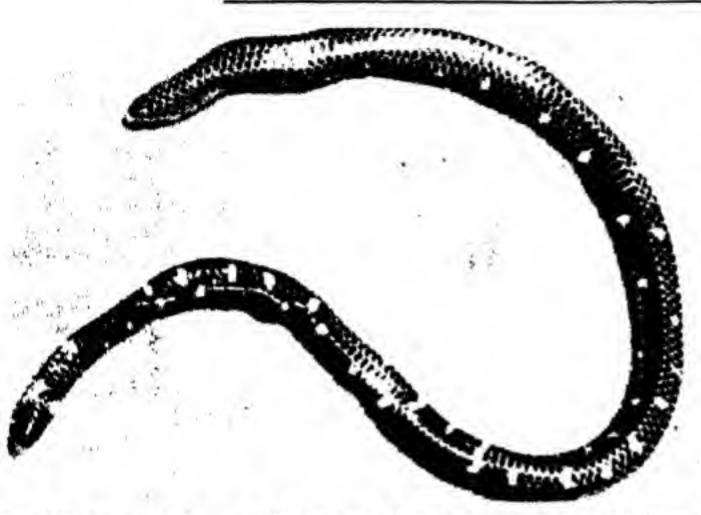


Fig. 4. The underside of a rough-tailed snake. Note the spots and blotches on the belly

hese creatures are the adaptations of their burrowing mode of life.

About 44 kinds of these snakes have been described so far from the nountainous districts of South India and Sri Lanka. However, herpetogists have paid very little attention to these interesting creatures. In the ircumstances, it will surprise no one hat the published work on Uropelts has been infrequent and far less compared with other kinds of snakes, because these small snakes inhabit the wooded districts often at very high altitudes easily escaping obsertation and capture.

The Uropeltids are inoffensive in isposition. They never make an attempt to bite if handled or irritated. When picked up they try to entwine themselves round our fingers and ove to be carried to long distances in that position.

These burrowing snakes are rilliantly coloured, which is an inusual feature for their secretive abits. They are generally coloured ed, orange or yellow, and some black orms are remarkable for their iridisence. They feed on insects, worms and grubs. They produce living

young ones.

Economic considerations and other monetary pressures on utilization of forest land have resulted in the gradual clearing of huge trees and 'sholas' which are the main ecological niches of these primitive snakes. It is too much to expect of these lowly

evolved creatures to migrate to suitable habitat elsewhere and in the process, we are not sure, how man of them could make it or disappear from the scene.

It is time that effective steps at taken by all concerned to protect these harmless and interesting frog and snakes from total destruction a they too would contribute to the ric and variegated fauna of our country We should rather consider them a our prized possessions considerin the fact that apart from Sri Lank and W. Ghats, the Uropeltids as found nowhere else in the world The forest officials should educat the forest labourers about th educative and scientific value of these rare creatures so that they ma not be killed by mistake. An lastly we should realize that with th speedy wiping out of forests, time i running out for these rare species

T.S.N. MURTH
Asstr. Zoologis
Zoological Survey of Indi
Madra

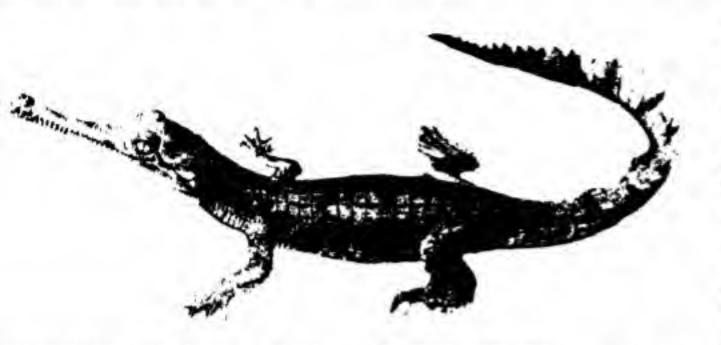
Gars and gharials

I is interesting to note the similarities between Gars and the Crocodiles (Gars, S. R., May 76)

The crocodilian evolution is believed to date back to a period over 200 million years, i.e., between Permian and Triassic. However, the oldest crocodilian fossil known to-date is of Proterochampsa barrionuevoi

discovered from Triassic beds of Western Argentina. Another foss of uppermost Triassic, discovere in Arizona, was Protosuchus. These crocodilians together with ferothers formed a group calle Protosuchia. Protosuchians wer moderately small crocodilians around 1.5 m in length. They were





contemporary to the gigantic Phytosaurs, which were strikingly similar in appearance to modern crocodilians and probably their habits were crocodilian-like. The similarities were in the skull with elongated jaws beset with sharp teeth and the large body posture. However, after the end of Triassic, when the Phytosaurs became extinct, their ecological niche was quickly occupied by the then crocodilians.

From the Protosuchian ancestors evolved the Mesosuchians represented by forms like Teleosaurus and Steneosaurus. These forms lived abundantly from lower Jurassic to the end of Cretaceous. In these forms the nasal passage was completely separated from the mouth cavity.

During Cretaceous, two groups of advanced crocodilians—the Sebaco-suchians and the Eusuchians arose from the Mesosuchians. The Sebacosuchians line of evolution was represented by forms like Sebecus and Baurusuchus. This line was probably restricted to the South

American continent and it soon became extinct. The Eusuchian line culminated in three groups of modern crocodilians— Crocodiliade, Alligatoridae and Gavialidae. Crocodilidae includes the True Crocodiles (Crocodylus sp. and Osteolaemus sp.) and the False Gharial (Tomistoma schlegelii): Alligatoridae includes Alligators (Alligator sp.) and Caimans (Caiman sp.) and Gavialidae includes the Indian Gharial (Gavialis gangeticus).

The gharials are exclusively fisheating reptiles inhabiting large rivers in the north of the Indian subcontinent. They are the oldest crocodilians believed to have descended directly from the long-snouted Teleosaurus. Fossil forms have been described from the pliocene deposits of the Siwalik hills and Narbada valley. Their evolutionary sequences follow an elongation of the snout and the multiplication of teeth. Pre-Miocene Gavialids from South America and Pliocene Gavialids from Africa have also been discovered. Breaking up of the Gondwana land is probably the cause for the present day confinement of the Gharials of India.

Pisces are primarily aquatic an aquatic reptiles are secondarily se Some of these aquatic animals during evolution became highly specialize fish-eaters by following an elongation of the snout for an easy reach to th prey and the teeth multiplication for certain catch. Such high specialized forms include the Gar-Ichthyosaurs, Phytosaurs, Gharial etc. Due to their similar mode of life these forms have a superficia resemblance to each other. This is what is known as convergen evolution-development of similar adaptive features in differen groups in response to the similar habit and habitat. The Gars an the Gharials look so similar! It is also interesting to recall Dr Behura' information (S. R., May 76) tha gars are called alligato gars attaining a length of abou metres which nowadays i the normal size for many crocodi lians. These and other similaritie between gars and crocodilians, how ever, are a mere chance of conver gence and they do not oblige any direct phylogenetic relationship.

> LALA ASWINI KUMAR SINGI Research Schola Gharial Research and Conservation Unit Tikerpada-75912.



IEWS & NOTES

Dr. M.L. Munjal —an interview

THE problem" said Dr. Munjal answering one of my questions, is not of lack of facilities—unless ne wants to work only on the prolems of interest to the West—but hat of environment, values and riorities." It was one of the most iscussed topics in scientific circles e was commenting upon—the rearch facilities in our country—the ne which some scientists lay blame in for their low quality research.

Our looking towards West hinders ur progress. It changes our values, ur preferences and, as a result, our nvironment. "Our scientists do not ive a young scientist the credit he eserves for his research until the Vest recognises him; and so everyody does research which would ttract the attention of the West" aid Dr. Munjal, referring to the vicius circle we are in. It becomes his ight to say so, for though he is winner of INSA young scientist ward for 1975, is a member of varius engineering institutes, is on the ditorial board and referees of many ournals, both Indian and foreign, e has yet to step his foot outside ndia. He believes in "going broad as an equal to his contempoaries there and not as one of those who go for 'higher' education". oday, after having gained recogniion abroad through his publications, e is looking forward to a foreign rip on sabbatical leave from the ndian Institute of Science (1.1.Sc.), Bangalore, where he is presently an Assistant Professor in the Department of Mechanical Engineering.

Born on April 4, 1945 in Multan, West Punjab, Dr. Munjal had his schooling and college education at Hoshiarpur and Chandigarh respectively. In 1968, he did M.E. specialising in internal combustion engineering at I.I.Sc. and subsequently Ph.D. while he was lecturer at the same institute. One of the four sons of an utensil vendor who had no opportunity to go to a school, Dr. Munjal has high regards for his father. "He struggled and worked overtime all his life to spend every paise to give me and my brothers good education-his only cherished ambition in life" said he. He drew from him the prime inspiration though the encouragement came forth from other quarters as well.

Why did he take up theoretical research? "When I look back, I think there was something I was born with." To provide an evidence for this, he has something strange to say: "I distinctly remember that before I went to school, my uncles used to remark about me-'The child remembers his previous birth, otherwise, how could he learn so much (mostly arithmetic) in so short a time." Such offhand remarks, he claims, spurred him to live upto the reputation and thereby eventually instilled in him a desire to go for theoretical research.

For the past eight years, Dr. Munjal has been doing research on the control of exhaust noise of automotive engines and turbojet engines; and vibration control with specific application to engines and automobiles. "One of the major consequences of my research," he claims, "is that exhaust mufflers can now be designed on the table without resorting to hit and trial methods." The Indian National Science Academy Award for young scientist that he received is, in fact,



Dr. M.L. Munjal

for his contributions to 'Noise Con trol and Vehicle Dynamics.'

As regards the best piece of research he had done to date, Dr. Munjal says it is the algebraic algorithm that he developed for the analysis of linear dynamical systems. "It enables one to write down the sinosoidal response of any vibrational system, mechani cal, acoustical or electrical, howso ever complex, directly without solv ing simultaneously a large numbe of equations," he said. How did he arrive at it? "Primarily developed by mathematical induction," replied he, laughing, "an outcome of my old habit of playing with numerica sequences." Today, according to him, his algorithm has proved itsel a potential tool for the synthesis of a filter, for example, vibration isolato or acoustical muffler of given require ments.

"Has he anything to say on the popularisation of science in the country?" I asked. "The need of the day," said he, "is not popularisation of science but application of science and technology to rurs areas." But, are our scientists doin anything of the sort? As he claim the initiative has already been to at various institutes including I.I.S. "Many of us," he said, "have take up research projects on fluidy pump, solar energy, biogas plan bullock cart, etc."

DILIP M. SALW



Caution about breast injections

SMALL breasted women who want larger breasts should of let any physician inject quid silicone into their breasts, uch injections could be lethal or ause some complications or local ffects.

According to Drs. Richard Ellenogen, Rita Ellenbogen and Leonard
tubin of the Stonybrook Medical
chool, New York (Journal of the
merican Medical Association, 243:
3) 308-309, 1975), granules of silicone
nigrate through the body and enter
ne liver, apart from its presence in
reast mass where it is injected.
They say that silicone should now be
onsidered as a possible cause of
ranulomas in a suitable host.

Since its introduction in 1965, imethicone (injectible silicone uid) has been known to produce ome undesirable side effects. Inially it was thought to be well olerated by tissues, while more operience and longer in situ observators revealed that the substance was ot as inert as originally thought of and a few systemic reactions were officed.

The scientists report about two ans-sexual men and a woman, who eveloped (following silicone injectors) adverse systemic effects; like agration, hepatic disease manifested granulomatous hepatitis, hypomentation and serious illness. In

another case, a woman was injected under each breast a single large dose of silicone while driving home with a friend she became unresponsive. She was taken to a hospital and died ten hours later. Autopsy revealed greasy fluid at injection sites. Absorption spectrography revealed high concentrations of silicone in lungs, kidney, liver and brain in that order. Cause of death was due to severe acute bilateral pulmonary edema, secondary to intramuscular injection of silicone.

There is, however, nothing harmful about surgical implantation of silicone gel within a silicone rubber sac beneath the breasts, which has been used for augmenting the breasts since 1962. About 100,000 such implantations have been done since then,

without any adverse effects. The saprevents the silicone from wandering The mobility is apparently what causes the trouble. Some plasticular surgeons inject a small amount of silicone with a fine needle above wrinkle and let the silicone fill the crease.

Dr. Ellenbogen and his team clair that systemic response of silicone is because of its transport by migrator; phagocytes to the tissues. The cata strophic systemic effects of silicone injections suggest that considerable research is needed, before release of this potentially lethal and debilitating substance for general clinical use

R. RAGHUNATHAN Nashville, Tennessee, 3720. U.S.A

Pesticides in our foods

IN these days of intensive agricultural practices, pesticides are invaluable in the promotion of farm productivity and protection of agricultural products during storage, besides their use in the control of certain vector-borne diseases such as malaria, typhus, yellow fever, etc. To avoid the annual damage to agriculture by insects, noxious weeds and rodents which is estimated at Rs. 5,000 crores in our country, the use of pesticides is steadily increasing both in tonnage and in variety. The excessive use of pesticides is posing potential health hazards not only to livestock and wild life, but even to human beings, either directly or indirectly through the food chains. Besides, pesticides could have other damaging consequences such as adverse effect on soil fertility and phytotoxicity. They can also interfere with desired use of soil and water, causing major problems of pollution. However, serious incidents as a result of pesticide use are yet to happen in India and the total ban on the use

of DDT in countries like America and Canada is a warning to others. It is, therefore, imperative that the problems arising out of the increased use of pesticides in this country are thoroughly studied to avert the ecological catastrophe.

Production and consumption in India

The era of synthetic organic pesticides started with the discovery of DDT in 1942. In India, imported formulations of DDT and BHC were introduced in 1947-48, but the manufacture of BHC commenced in 1952. Since then the use of pesticides is steadily increasing and the requirements for 1975-76 is expected to be 58,844 tonnes and projection for 1983-84 is estimated at 1,49,795 Now 41 products in technical grade are being manufactured, under different classes of pesticides and there are more than 1400 formulations being used in India which is about 65% of the total pesticides requirements of this country.

xposure to pesticides

Human beings are exposed to esticides during their production, ormulations, packaging. transortation application and to egetation. These occasions provide pportunity for contact, inhalation nd even ingestion of these toxic gents. In addition to occupational xposures, entry into the food chanels of man and his economic species nay occur through residues in or on aw agricultural commodities or in processed or packed food produced herefrom. Traces of pesticides may e ingested by the young and old, he sick and healthy and for long or hort periods at various stages and ven throughout the life cycle. This ed to the monitoring of various foodtuffs in the different parts of the country. The details are discussed elow and summarized in the Table 1.

Cereals, pulses and their products

A total of 774 samples collectd from various sources such as armer's houses, FCI godowns and narkets of Hyderabad, Delhi,

Mysore, Ludhiana and Pantnagar analysed. Thirtyfive DCT cent samples were found to contain residues of DDT, BHC, malathion or captan. A personal communication from Dr. K. Krishnamurthy of the Indian Grain Storage Institute, Hapur revealed that mixing BHC/DDT with the grains is a common practice in villages around Hapur and Delhi.

Oilseeds and oils

Twentynine samples of different oilseeds and oils from Delhi have bad did not contain any chlorinated hydrocarbon insecticide.

Vegetables and fruits

Out of 727 samples, as many as 514 samples (71 per cent) are reported to contain pesticides. At Mysore, all the 300 samples leafy vegetables contained of excessive residues of BHC:

been reported to contain DDT. The residues were very high in the mustard oil, sesame oil and coconut oil while samples from Hyderasamples contained DDT; at Hyder bad 183 of the 328 vegetable sample contained pesticides above the tolerance limits set by the Food and Drug Administration of U.S.A The pesticides commonly detected were aldrin, DDT, BHC, chlordane endrin and Heptachlor. Residue on fruits was reported only from Hyderabad, where 82 per cent o grape samples were found conta minated with malathion, methy parathion and parathion.

at Ludhiana 4 of the 10 origina

Milk and milk products

Out of 15 samples of milk from Hyderabad and Pantnagar, 11 con tained chlorinated hydrocarbon in secticides. Analysis of two sample of butter have been reported to contain DDT (below 0.5 ppm)

Eggs

Six samples of eggs collected from Pantnagar are reported to contain DDT, while 8 of the 15 sample from Hyderabad contained bot DDT and BHC, which was higher than the tolerance limits laid down by the authorities.

Storage of chlorinated hydrocarbo insecticides in body tissues of ma

On direct or indirect exposur of animals and human beings, th insecticides tend to accumulate i their body fats. Studies have show that the daily content of DDT i meal in our country might be about 0.2664 mg, while concentrations of DDT in body fat vary from 12. ppm to 31 ppm. This level of DD in human fat is the highest in th world; the level of DDT in differen countries of the world has been re ported to contain 1.8 ppm to 19. ppm. (Table 2). However, spite of higher concentrations of DDT, there has not been a sing record of any adverse health effec reported in this country.

Table 1. Pesticide contamination of food samples

Commodity camined	No. of samples examined	No. of samples found contaminated	Pesticides detected
Vheat grains	659	190	DDT, BHC, malathion
Vheat flour	2	2	DDT
ercels	77	56	DDT, BHC
Lice	4	4	DDT
ulses	32	16	DDT, BHC
pilseeds and oils	39	29	DDT
egeta bles	727	514	DDT, BHC, adrin, chlor- dane, endrin and heptach- lor
Frapes	44	36	Malathion, methyl para- thion and parathion
filk	15	11	DDT, endrin.
lutter	2	2	DDT
485	21	14	DDT, BHC
futton and Beef	18	5	DDT, endrin
at of buffaloes, goat and cows	63	61	DDT

Table 2. DDT in body fat of human beings in different countries

Country	A dilata	Per cent				
	(ppm)	in total				
Section 1						
Australia	1.8	56				
West Germany	2.3	57				
England	3.3	67				
Denmark	3.3	82				
Canada	4.9	67				
taly	5.0	64				
rance	5.2	67				
Zechoslovakia	9.6	43				
lungary	12.4	48				
srael	19.2	56				
ndia	12.8 to 3	1 37				

Effects of pesticides on man

The effects of pesticides on man have been undesirable and alarming. Sometime large numbers of persons have died on eating food contaminated accidentally with pesticides. To mention a few: 330 deaths occurrd in Turkey due to eating seed grains reated with hexachlorobenzene; 80 leaths in Colombia from eating lour contaminated with parathion; 7 deaths in Mexico from eating parathion. In ugar containing ndia, no accurate data are availble on the morbidity and mortality rom the toxicants. However, the ecords of health and agricultural lepartments of Maharashtra, Bihar, Mysore, Madras and West Bengal

during the last five years show that pesticides have been responsible for 690, 185, 139, 1503 and 889 cases of poisoning respectively. The poisons detected in over 80 per cent of cases are parathion, malathion, diazinon and endrin. The fatalities are generally due to negligence or ignorance.

The absence of short-term effects in human beings is no guarantee to their long-term safety. As pesticides have been used extensively only in the last two decades, there could have been other important effects that have not yet showed up, although there is no basis at present for expecting such effects. Some disturbing effects could be related to the ability to produce cancers, mutations and congenital in utero malformations. They are also capable of causing impotence, etc.

Suggestions

As pesticides are vital to the control of agricultural pests and vector borne diseases, their use cannot be discontinued. It is, therefore, suggested that one should follow strictly the following safety measures so that the benefits of pesticides are not denied on account of their negligent use.

- 1. Mass education of cultivators regarding the safe use of pesticides.
 - 2. Pesticides should be kept under

After use the empty containers should be destroyed or burnt properly.

- 3. Pesticides should be applied only in recommended dosages to crops when pest population has exceeded the economic threshold, i.e. the level at which a significant cropless may be expected if no controlled.
- 4. Cattle should not be allowed to graze on the treated crops.
- The produce should be harves ed after the waiting period is over.
- Direct mixing of insecticidadusts with the food grains is to be avoided.
- Consumers should be advise to wash thoroughly with water an peel all the vegetables and fruit before use, because it remove substantial proportion of pesticide residues.
- 8. Lastly, provision should be made for the quantitative estimation of the pesticide residues in various food stuffs and therefore it is recommended that all the analytical laboratories should be equipped with the latest sophisticated instruments for determining the microquantities of pesticides.

P. K. GUPT R.C. GUPT Industrial Toxicolog Research Cente Lucknot

HYBRIDISATION (Continued from page 470)

urther reading

Chaleff, R.S., and Carlson P.S., omatic Cell Genetics of higher lants, Ann. Rev. Genet., 267-276,

(1974).

 Cocking, E.C., Plant Cell Protoplasts, Ann. Rev. Plant Physiol., 23.: 29-50 (1972).

3. Harris, H., Cell Fusion, Claren-

don Press, Oxford, 1970.

Street, H.E., Plant Tissue and Celebraters, Blackwells, Oxford, 1973
 Street, H.E., Tissue Culture and Plant Science, Academic Press, 1974



Silk-the queen of fibres

TILK is a natural protein fibre produced by the living insect, ne silkworm. It has all the desirale qualities of a fibre like softness, trength, elongation, etc. Besides, lk has a bright lustre. It is lighter an other natural fibres, the specific ravity being 1.25-1.27. Silk is an xcellent insulator of heat, hence it warm in winter and cool in summer. Depending on the atmospheric conitions, silk can absorb about 20% 25% moisture without becoming wet, hich makes it comfortable to wear. Il these qualities make silk the Queen of fibres."

This is the age of synthetic fibres: crylene, nylon, rayon, etc. These bres also have good qualities, yet no ynthetic fibre is equal to silk. The lk filament spun by the worms is bout 15 \mu-20 \mu in diameter and is an esembly of many finer fibres. Silk eveals many threads bundled togeter when seen magnified many mes, but the synthetic or man-made bres looks like a piece of rod.

listory

The production of silk started first

in China about 4600 years ago. The Chinese queen Ling Shi once happened to drop some silk worm cocoons into a tub of boiling water. Glutaneous substances covering the cocoons were dissolved in water and silk filaments released. The Queen put several filaments together and made a piece of silk yarn. Shortly, she could weave a fabric. It was about 120 B.C. when silk was brought to Europe and other parts of the world.

India has the unique distinction of producing all the four commercial varieties of natural silk. These are mulberry, tasar, eri and muga. The country ranks fifth amongst leading mulberry producers accounting for over 5% of the total world production. In the 13th International Sericulture Congress held in 1975 at Tlemcen, Algeria, India's total production of mulberry silk was 2445 tonnes (1974 figure). It is also the second largest tasar producer with 10% of the global output. India has the world monopoly of fabulous golden yellow silk 'muga' produced in Assam only.

Silk producing species

The silk spinning moths belong mostly to the family Bombicida which consists of the sub-families (i) Bombycinae, (ii) Saturniinae, and (iii) Thaumethopoeinae. In the Bomby cinae sub-family, the most importan commercial species is Bombyx more It is a domestic species which produ ces mulberry silk. The worms ea mulberry leaves and hence the nam of the silk. The large and beautifu moths of the Saturniinae sub-family produce 'wild silk' of commerce Antheraea pernyi, Antheraea yamma mai, Antheraea mylitta and Antherae proylei produce tasar silk. Attacu ricini and Antheraea assamensis pro duce eri and muga silks respectively In the sub-family Thaumethopoeinae the Anaphe species found in Africa is important but owing to comple structure of their cocoons the un winding of silk becomes difficult and hence are not much popular.

The technique of silk production by different species of silk-moths interesting. It closely resemble the life-cycles of the moths (Fig. I). We now know that the life-cycle of the four commercially important silk moths are more or less similar.

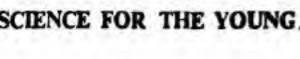
Life-cycle

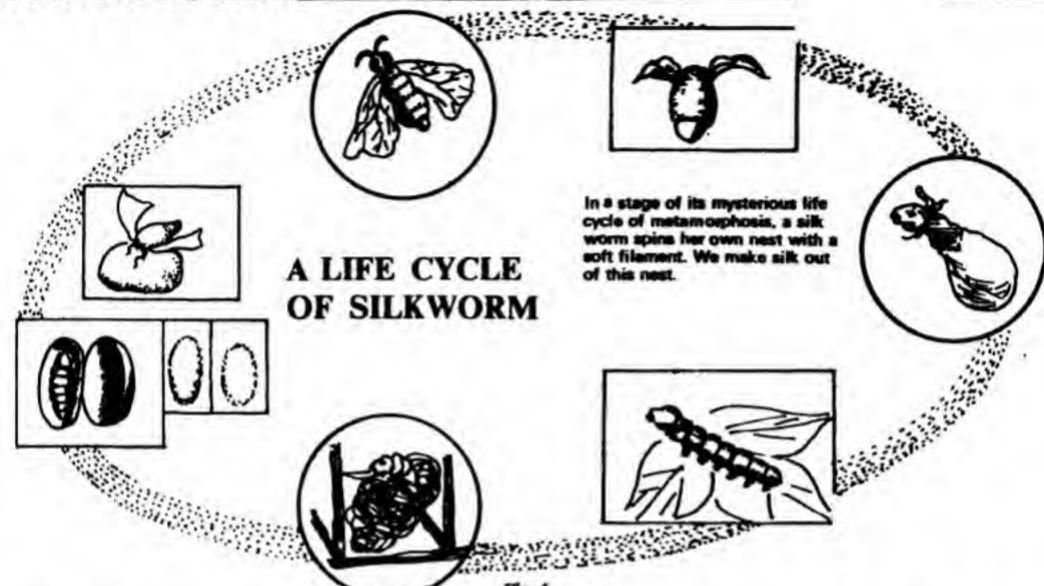
Moth and laying of eggs. A femal silk moth lays about 300-500 eggs. After laying, it does not take an food and dies within 4-5 days.

Hatching. The eggs produce hatch within 10-20 days under natural conditions. The newly hatched sill worm eats mulberry, oak, sal, assat castor, kul leaves, etc. They weigh about 5 mg and are 3 mm long

Larva or matured worm. The tiny mulberry silkworms feed of mulberry leaves whereas the will varieties producing tasar, eri and muga feed on other leaves. They sleet and cast off their skins four time a month. In short, silkworms group within a month.

Spinning. When fully grown, sill worms cease to feed and their ski changes colour. Their body shine because at this stage it is filled up





with liquid silk indicating that they are ready for spinning. Rearing upon their hind legs, the silkworms tearch for a suitable place to weave their cocoons. The mulberry worms can be reared on trays for spinning, whereas the wild worms to the same on food plants.

Cocoon. The liquid silk is found n two glands of the silkworms. Here a reaction called 'transaminaion' was noted in various tissues of hese insects. In addition to the common sources, transamination is key reaction in maintaining a palanced amino acid pool for reguating protein synthesis from nonrotein sources like the keto acids. uch reactions have been demonsrated in fat body, alimentary canal, nuscle and haemolymph. Searches ave revealed that aspartate and lanine-aminotransferase enzyme eactions are most active, particularly n the silk glands of Bombyx mori, additional hereby providing an uantum of amino acids to the pool or protein synthesis.

From silk glands, the liquid

common exit tube called 'spinneret' in the worm's mouth. As it emerges, the liquid silk hardens into very fine filaments, coated and stuck together by a gummy substance called 'sericin' which comes from two other nearby glands. The silk spun by the worm is, therefore, a twin filament held together in the form of a single strand by the sericin cement. During throwing of liquid silk, the worms rotate their heads back and forth like the cardinal number 8. Gradually: they surround themselves with a strongly built cocoon made up of a continuous silk strand that may be 1000-1500 m long. The operation takes about 2-3 days. After releasing the entire silk, the worms shrink in size and become wrinkled. At this stage they are called 'pupae' and remain inside their cocoons.

Moth or butterfly. The pupae inside the cocoons now develop their shape and turn into moths or butterflies. It takes about one month in summer and three to five months in winter. The moths finally secrete some fluid on the inner walls of the shells. The layer where they through the fluid gets softened. They could be the layer and emerge out of the could be after emerging, the female and the male moths mate. The female moths lay eggs and both the moths die after 3-4 days.

Stiffing and Cooking. When the moths cut the cocoon layers an emerge, the continuity of the sil filament is broken into thousand of short pieces. This makes it us suitable for reeling. The harveste cocoons from which moths have not emerged are widely used for sill reeling or silk-production. To avoi unwanted emergence, the chrysal or pupa is killed by heating. Th is called 'stifling' which is per formed within a few days of harves ing of the cocoon. It is done b baking in sunlight or in an air over Sometimes stifling is also done i het air or steam. The cocoon thus stifled can be kept indefinitel without any appreciable damage It is, however, advisable to reel th cocoons within a few months after harvesting because long storag deteriorates reelable qualities, ult nately affecting the technological roperties of the fibre.

The mulberry cocoons are generalboiled in hot water or steamed for few minutes. With this, the sericin ets softened. The softening of the ericin by either of the treatments r both is called 'cooking' which acilitates the unwinding of silk lament. The cooking of tasar nd muga cocoons requires more oiling or steaming. Some additioal chemical treatments are also eeded for proper softening beause the chemical nature of the vild sericin is somewhat different rom that of mulberry. The eri ocoons cannot be recled, as in this ase the moths cut the cocoons and romptly emerge causing he discontinuity of the filament. cooking is mainly responsible for proper reeling or better yield. The eri, the defective products of other varieties like pierced, doubled or stained cocoons, and the reeling wastes are used as a raw material for spun silk.

After proper cooking, the cocoons are deflossed mechanically to get the end of the continuous filament. Several cocoons are fed per end of the reeling machine to produce silk yarn of a particular thickness. These yarns are then twisted or doubled and used for fabrication to get the bright silk cloth.

NIRAPADA GUPTA
Division of Fibre Science
ANSUMAN HAJRA
Division of Nutrition, Physiology and
Biochemistry
C.S.W.R.I. (I.C.A.R.), Avikanagar
304501 (Rajasthan)

system, three pairs of jaws and legs veined wings, stripped muscles, an the rest!

It is rather unexpected, too, that the smallest adult vertebrate is not a fish, but a frog; and that the larges elephant would have ample clear rance top and bottom inside a larg whale's skin.

The weight of most land verte brates ranges from ten grammes to 100 kg. Why is this narrow rang so popular?

A disadvantage in being very small is that you are not big enough to be out of reach of annoyance by the more inorganic molecules of the environment.

The molecules of a fluid-like water are rushing about in all directions. They run against any object in the water, and bounce off again. When the surface of the object is bigenough for there to be thousand of such collisions every second, the laws of probability will see to it that the number of bumps on one side will be almost equal to that on the other; we call the resulting pressure steady average fluid pressure.

But when the diameter of the object falls to about one-thousandth of a millimeter, it may easily happen that one side receives a rain of bumps while the other is spared. The result is that the smallest or ganisms are kept in a constant St. Vitus's dance, christened "Brownian movement" after its discoverer, the famous nineteenth-century English botanist, Robert Brown.

It is impossible, however, simple to magnify an object without changing its shape —if you do so, without meaning to, you have changed a its properties. For the surface in creases as the square of the diameter the volume as its cube, and so the amount of surface relative to bulk must diminish with size. A big African elephant is one million times as heavy as a small mouse

Surprise in sizes

TIZE, which we are so apt to take) for granted in ourselves and in ne organisms around us, is one of ne most serious problems with hich evolving life has had to cope. The largest living things are he big trees of California ith a weight of nearly 1,000 tons. Vhales are the largest animals; ome of them weigh more than 100 ons. They are not only the largest xisting animals but by far the argest which have ever existed, for he monstrous reptiles of the seconary period never weighed more han 50 tons.

It is among the molluscs that the argest invertebrates are to be found; ome giant squids weigh one and a alf tons. The runner-up, strangely nough, is a huge jellyfish which as a disk over seven feet across and 18 inches thick, with bulky

tentacles five feet long hanging down below. One of these weighs as much as a good-sized horse.

What we might call the most successful of all invertebrates, the ants, hardly ever reach even one gramme in weight. Indeed, the small size of most insects is at first hard to believe. If we buy an ounce of fleas, we would have the pleasure of receiving over 80,000 of them!

Nature seems to have found it unprofitable to construct a vertebrate out of fewer than several hundred million cells. Within the groups there is great variation.

It is a surprise, for instance, to find a frog that weighs as much as a small terrier. It is a still greater surprise to know that there exist fully formed adult insects—which are smaller than the human ovum. Yet they have compound eyes, a nervous But the amount of surface for each gram of elephant is only onenundredth of what it is in the mouse.

The most familiar effect of this surface-volume relationship is on the rate of falling. The greater the mount of surface exposed relative to weight, the greater the resistance of the air.

If a mouse is dropped down the haft of a coal mine, the acceleration due to gravity soon comes up gainst the retardation due to air esistance, and after 100 feet or o a steady rate is reached, which ermits it to reach the bottom dazed ut unhurt, however deep the shaft. A cat, on the other hand, is killed;

man is not only killed, but horribly nangled; and if a pit pony falls own, the speed at the bottom is appalling that the body makes hole in the ground.

Relative surface is also important or temperature regulation in warmlooded animals; for the escape of eat must be proportional to the urface through which it leaks.

As heat is derived from the comustion of food, a mouse must eat
nuch more in proportion to its
weight than a man must—to make
up for its unavoidable extra heat
coss. The reason that children
need proportionately more food
than grown-ups is not only due to
the fact that they are growing, but
also to the fact that their heat loss
to relatively greater. A year-old
to aby loses more than twice as much
than does 80 kg man.

The big animal inevitably fails to be a mere scale enlargement of its maller relative. Everyone knows he small-eyed look of an elephant or of a whale. To obtain a good mage, an eye has to be of a certain boolute size; and once this size is eached, any advantage due to furher enlargement is more than countribalanced by the difficulties of

construction, just as little advantage is to be gained in photography by making a camera more than full plate size.

Coming back to the advantages and disadvantages of size, at the outset, it is not until living units are free from the frenzy of Brownian movement that they become capable of regulated locomotion. The first step in size is to become so much bigger than ordinary molecules that you can forget them.

But even then we are microscopic. Only by joining together tens or hundreds of thousands of cells can we make headway against such brute forces as currents. Size also brings speed and power, and this is an advantage in exploring the environment.

However, even quite small migratory birds regularly travel thousands of miles. And think of the migration of tiny eels across the Atlanti or of baby salmon down great river

Before a real brain can be constructed, the animal must consist of tens of thousands of cells. The intelligence of a rat would be impossible without enough brain cell to outweigh the body of a bee, while the brain of a human being outweighs the majority of existing animals.

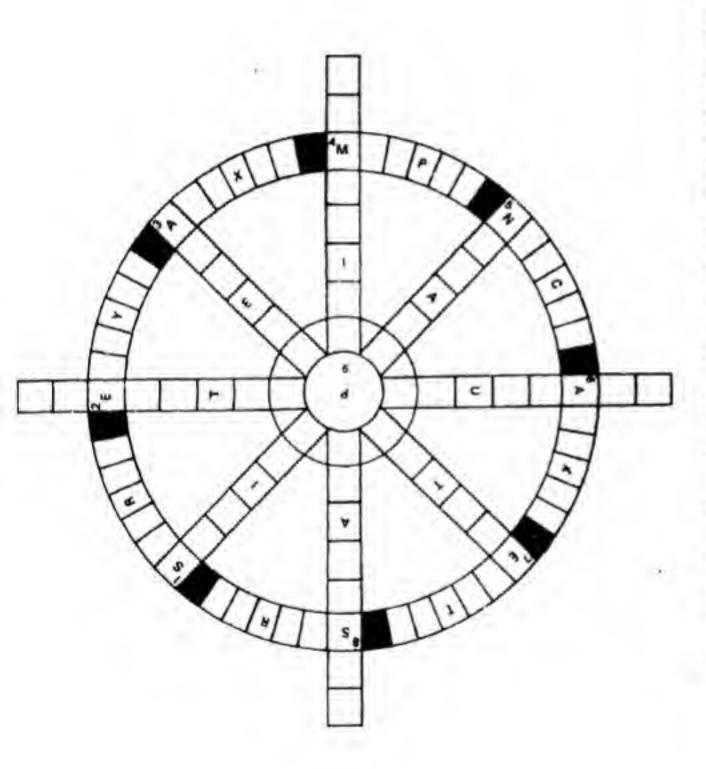
Man, in fact, is a very large organism. During his existence his multiplies his original weight be 1,000 million, and eventually contains about 1000 million million cells. He is a little more than half way up the size scale of mammals and nearly two-thirds up that of the vertebrates.

MAHARAJ K. KOU Department of Chemistry University of Kashmi Srinagar-19000

M	11	1	K		4		Ĺ	A	°c	T	'n	15	'e		
6	0	1	T	R	E			°c	A	В	8	٨	G	E	
	D	F		R	A	"G	1		L		E	L	G		
Ď	1	E	т			н		"T	c		s	7		34	
	N					E		0	1		E		0		т
	E	П			ø.	E	"A	N	U	* *			L	0	w
							"L	E	м	0	N				
	W	24 M					c	D		Y,	E	L	0	7	
w	н	E	Ä	T		"c	0			»A	N	E	M	1	A
45	E	A	L			0	н	ä	E	т	E	L		A .	
	٧	T	м			C .	0	R	H	0	1	L		c	
			0	E	č	0	L	E					*5	1	
		ъ	N	1	0	N		A			ľ	R	0	H	
			D		38	U	R	D					Y		
					0	T			*6	U	A	٧	A		
				₩.	A	5	E	1	N						

Solution to crossword puzzle published in S. R., July 1976

Science Wheelword Puzzle



CLUES

The Rim (Clockwise)

- A polysaccharide.
- Organic catalyst.
- 3. The other name for 'blindness'.
- 4. Disability to see distant objects.
- One of the B-complex member.
- Oxygen lack.
- 7. A drug which induces vomiting.
- 8. Occurs due to lack of vitamin C.

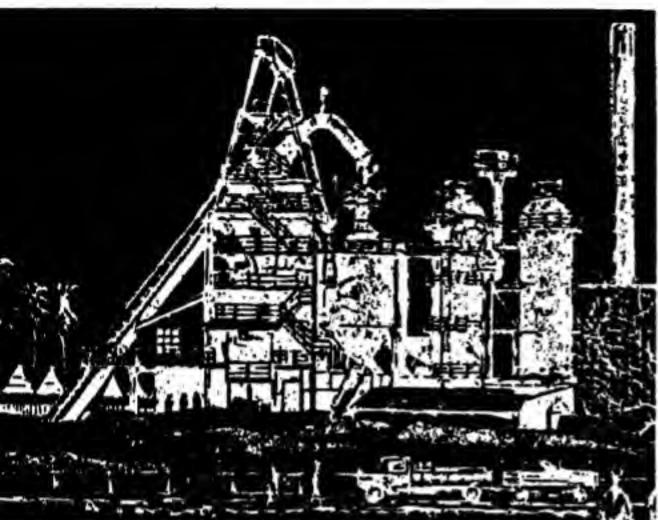
The Spokes: (The words begin from the common axle clue No 9.)

- One of the two types of bases in a nucleotide.
- These are one of the formed elements of blood.
- State of increased temperature of the body.
- 4. One of the fluids found in the inner ear.
- Otherwise called salivaryamylase.
- The 'Master gland' of the endocrine system.
- This bond is found in protein linking two amino acids.
- Nervous affliction marked by loss of motor or sensory function of nerves.

G. N. LAKSHMINARAYAN

Coimbatore Medical College

Coimbatore-14



SCIENCE IN INCERY

Electronic score board

THE Central Scientific Instruments Organization, Chandigarh, as developed an electronic score oard. The complete system consists nainly of two identical electronic core display boards, and a portable ontrol desk located at the central lace. The data is entered and conrolled through keys fitted on the esk control. The score board ontains 168 multiple alphanumeric haracters of three different sizes , 71" & 6" high, so that one can asily read from a distance of bout 200 meters. Each score oard displays simultaneously the ames of four teams, their countries nd the running scores, as well as ther the previous five rounds or ets or ten fouls for each team, etc.

In addition, each score board also displays either the game time or the IST time in hours, minutes and seconds. Each digit could be erased or rewritten without disturbing the other digits on the display boards.

Design of the system is based on the latest technology and devices. It uses semiconductor memories for storing data, ROMs (Read only Memory) for character generation using 5×7 dot matrics display (35 elements for one character). The system makes use of 14000 transistors and diodes, and about 1000 integrated circuit chips (ICs).

The system, which is first of its kind in Asia, is quite comparable in technology, reliability and much cheaper to the one available in the



Electronic score board (Display unit)

developed countries. The system would have wide applications for the display of arrival and departure of trains at the railway stations flight numbers, arrivals and departure, of aeroplanes at the airport; production schedules in factories; and for the display of important news in publishing house. This will have extensive exponential.

Radome

THE National Aeronautical Laboratory, Bangalore, has achieved a fairdegree of competence in the design, development, fabrication and installation of radomes. The capability built over the past decade covers a wide range of sizes, shapes and types of radomes, for a variety of applications.

Radomes are protective covering structures used for protecting radar and other electromagnetic devices from atmospheric and other elements without seriously affecting the electromagnetic characteristics. NAL has mainly been involved in the development of radomes for Cyclone Warning Radars and Air Traffic Control Radars. These are truncated spheres in shape and 6 or 17 meters diameter in size.

Geodesic dome construction of building a spherical structure by assembling a number of triangular elements has been used. The sizes of the triangular elements were arrived at after considering the structural and electromagnetic requirements, which are generally conflicting in nature.

Structurally, these radomes have been designed for wind loads upto 200 kmph, and ice loading upto 19.6 cm thick on the top.

The important electromagnetic requirement of keeping the attenuation due to radome within 0.7 dB has been maintained.



Radome

The structural design incorporates the use of rib moulded panel construction stiffened with high tensile steel stripes. The FRP panels are pigmented white for better weathering properties.

ONOSPHERE (Continued from page 466)

tself fully; much of it still remains hrouded in mystery. Man's incessant attempts at unravelling this mystery are, however, in progress all over the world and the day is not ar off when he will have a clear knowledge of the ionosphere.

urther reading

. Bennington, T.W. (1950), Short-

wave Radio and the Ionosphere, Iliffe & Sons Ltd.,

 Beynon, W.J.G. (1962), Monograph on Ionospheric Radio, Elesvier Publishing Company.

 Bugoslavskaya, N.Ya. (1962), Solar activity and the lonosphere, Pergamon Press.

4. Davies, K.A. (1966), Ionospheric Radio Propagation, Dover Publication Inc.

- Mitra, S.K., The Upper Atmosphere.
- Ratcliffe, J.A. (1962), Physics of the Upper Atmosphere, Academic Press Inc.
- Terman, F.E., Electronic and Radio Engineering, McGraw-Hill Book Company.



NDIA: THE ENERGY SECTOR, y P.D. Henderson Oxford Univerity Press, (1975), Pp XIV+191, is 30.

NERGY is everybody's concern. at least the communication nedia have strived hard to make it so. lut there are not very many books deling with this subject yet. However, here is a danger that the expectations f some of the readers may not be ulfilled as the contents of the book re not so comprehensive as the title uggests. The book is an extended ersion of a report which Prof. lenderson prepared for the World lank. He has collected a considerble amount of statistics concerning he energy use in the immediate past nd present, and a forecast of future eeds in India. The rearrangement f the data from various published nd unpublished sources into a mall, compact and readable volume purposive and useful. Neverheless, it leaves much to be desired s it mainly deals only with the ource of commercial energy specically coal, oil, gas, hydel and uclear energy, and one of their crivatives, namely, electricity. eccording to the book, the estimated hare of the commercial energy acreased from 32 to 52 per cent of the otal energy consumption in the eriod from 1953/54 to 1970/71. his means that the non-commercial ource of energy; firewood, charcoal, ow-dung, vegetable waste, etc., which oes not form part of the recorded

commercial transaction, still remained a large source of energy. The absolute value of the coal replacement weight of the non-commercial energy source has even gone up with the time.

While discussing the distribution of energy resources, the author points out that it is well balanced by nature across the whole country, e.g., Bihar and Bengal, which have plenty of coal supply do not have much of oil or hydel sources, while the North Western and Southern States which do not have coal are richly endowed with hydro power potential. The North Eastern States have plenty hydro power and some oil while Western States Mahanashtra and Gujarat, have oil in Bombay High and Gulf of Cambay.

The description of the various uses of energy is quite interesting. The absolute amount of energy consumed increased more than three times in the period 1953-54 to 1970-71, while the percentage shares of the various components of energy sources, viz., coal, oil, and electricity, changed considerably. The rate of growth of agricultural consumption of electricity in the decade (1960-61 to 1970-71) was over 14 per cent per annum. Over one quarter of the Indian villages were electrified by March 1974 and the number of irrigation pump sets and tubewells had risen to almost two and a half million. Then there is the disturbing observation that total commercial energy consumption increased during the decade at a considerably faster rate than national product. This was corroborated from the fact that the overall energy coefficient rose from 0.57 to 0.8 units per billion rupees of value added. This raises an important question. Is the increasing mechanization in the industry a measure of wasteful uses of energy? There is no attempt to answer such a question in the book, nevertheless it keeps coming to reader's mind as the power industry is highly capital intensive and has grown in India at an

extremely rapid rate, e.g., for the Fourth Plan period as a whole, the estimated share of power was over one sixth of the total outlays.

The author has discussed the original of power crisis in the recent year in some details. He finds that th reasons for not attaining the targe were delays in civil works and deliver of power equipments and inadequad of addition to transmission and dis tribution facilities. The low rain fall and slow snow melting added t these difficulties. Add to these th mismanagement in the coal industry which was least documented amon the other power industries. The spent less than 0.5 per cent of th industry's turnover in research an development, which in view of th prospective expansion of production and the problems that need invest gation was very low. The national sation of the coal industry would certainly improve the situation as seen from the post-script of the bool

Considering the importance of oil the author says that there is great scope for increasing the eff ciency with which the fuels as consumed and for substituting coa or electricity for petroleum pro ducts in a number of uses. H emphasises the case for reducin dependence on oil on the ground of cost saving and adds that the case is valid quite apart from an need to improve the balance of payment. On the other hand, h finds that India is not a heavy const mer of petroleum products in rela tion to its total national income Even the four fold increase in o price since 1972/73 would come t about 2 per cent of the GNP. the GNP were to grow at the officiall projected rate, i.e., 5.5 per cent per annum, the loss arising from deare petroleum imports would be mad good in less than six months. How ever the actual rate of growth i the past few years have been we below this figure. At present, Indi meets 30 per cent of its oil consump tion from domestic sources. Th uthor pinpoints the fact that too nuch should not be expected from he cuts in the use of oil, as a reducon in petroleum consumption is nly one of many possibilities that an be effected for energy savings. He feels that beyond a certain point, which is not easily determined, irect limitation of oil imports ould affect production and capacity to export.

About the possibility of using plar energy the author deliberates hat in the present state of technical nowledge, the growth of trees for rewood is probably the most effective use that can be made in India f solar energy as a source of fuel.

The author has a number of suggesons to offer on the problem of planing and practice in energy sector. ince no systematic quantitative anlysis of the experience of the past inestment projects exists, the estimates f future capital expenditures for rojects are often based on formula alculations, which may bear little elation to what has actually happend in the past. Hence the author uggests that a full system developent study of the power industry India should be undertaken. He so proposes that to simplify existng administrative relationships nd to enable the power system to be lanned on a national scale, the esponsibility for generation and ulk supply be assigned exclusively the Centre, leaving distribution

only as the responsibility of the States.

In the author's opinion the rise in oil prices has made little difference to the energy situation in certain respects; because many of the current problems of the energy sector are internal to India and arise in connection with the supply and distribution indigenous fuels. Hence he advises that so long as chronic energy shortages persist all energy products should be made expensive in relative as well as in absolute terms in order to promote greater economy and efficiency and to ration the demand for energy products. This would also enable the public enterprises earn large surpluses. Reader may ask: Will that make equidistribution of social benefits derived from energy use any easier?

K. CHANDRAKAR

Department of Physics

University of Rajasthan

Jaipur

LET'S DISCOVER SCIENCE by David Horsburgh, Oxford University Press, Delhi, Pp. 90.

Science, unlike fiction, does not arouse emotion; hence, is a poor

stimulant to a child's mind. Bu societies all over want to produc excellent scientists and technologists Children find science heavy because it is based on concepts which mus be explained. A child very often find these exercises boring. Science an technology. therefore, should b made attractive to children by no teaching them concepts, but makin them partners in simple experiments The child sees the illustrations, coll lects a few articles and fabricates simple device to do some work. Thi method interests a child. He the finds science and technology a stimulating as fiction.

David Horsburgh has done as excellent job of making science and technology an attractive subject fo the five volume children. In Let's Discover Science, the autho has tried to provide basic skills to children on science and technology The experiments are well illustrated and well printed. A child of Vt grade will have no difficulty in gras ping the language of the books. The author does not teach "concepts of science", he merely invites them to experiment with simple objects, and enjoy the thrill of working with simple devices developed by chil dren themselves.

The books are an excellent addition to scientific literature for children. At the end of each series there are notes for use of the teachers. The books are moderately priced.

NATIONAL SCIENCE TALENT TEST-1977

(N. C. E R T.)

CORRESPONDENCE COURSE

INCLUDING GUIDANCE FOR PROJECT REPORT
COMMENCES 10 AUGUST 1976
ENROLMENT ALREADY IN PROGRESS

DELHI PUBLIC COLLEGE OF COMPETITION

AJIT ARCADE BRANCH (Near L.S.R.College) KAILASH, NEW DELHI-48

Phone: 634068

T. R. MANCHANDA M.A. (Eng. Pol. Sc.) M.Ed. Principal

LOW COST TEXT BOOKS FOR BIOLOGY STUDENTS

(Subsidised by National Book Trust, India)
For B.Sc., B.Sc. (Hons.) & M.Sc. Students

MODERN TEXT BOOK OF ZOOLOGY
INVERTEBRATES

By KOTPAL, AGARWALA & KHETARPAL

Subsidised Price: Rs. 21.25

CYTOLOGY, GENETICS & EVOLUTION

By-P. K. GUPTA

Foreword by M. S. SWAMINATHAN

Subsidised Price: Rs. 12.00

RASTOGI PUBLICATIONS
SHIVAJI ROAD, MEERUT-250002

In accordance with the latest instructions of various examining bodies and based on latest trends in examinations

FOR SURE SUCCESS

Read

Arm's Objective & Short Answer Type Questions in

1.	Physics	Rs. 4.50
2	Chemistry	Rs. 4.50
	Mathematics	Rs. 4.50
	Biology	Rs. 4.50
	English	Rs. 4.50
	History	Rs. 4.50
	Economics	Rs. 4.50
	Commerce	Rs. 4.50
	General Knowledge & LQ.	Rs. 3.00
10.	Civics	Rs. 4.50

Published by:

YOUNG MAN & CO.

Copies available with all the leading book sellers of send your order with an advance of Rs. 5.00 by M.O.



Venus de Milo The Masterpiece with unchanged specification for over 23 centuries

Such masterpieces are common in classical objet d'Art but not in the field of Laboratory Chemicals.

The specification of Laboratory reagents stays a masterpiece of laboratory science only for a year or two.

The demands of ever-changing modern science and technology are so exacting for continuous progress that only a company of progressive tradition and status can dare to meet them.

Look to



SARABHAI M. CHEMICALS

For Tomorrow's Standards In Laboratory Chemicals Today

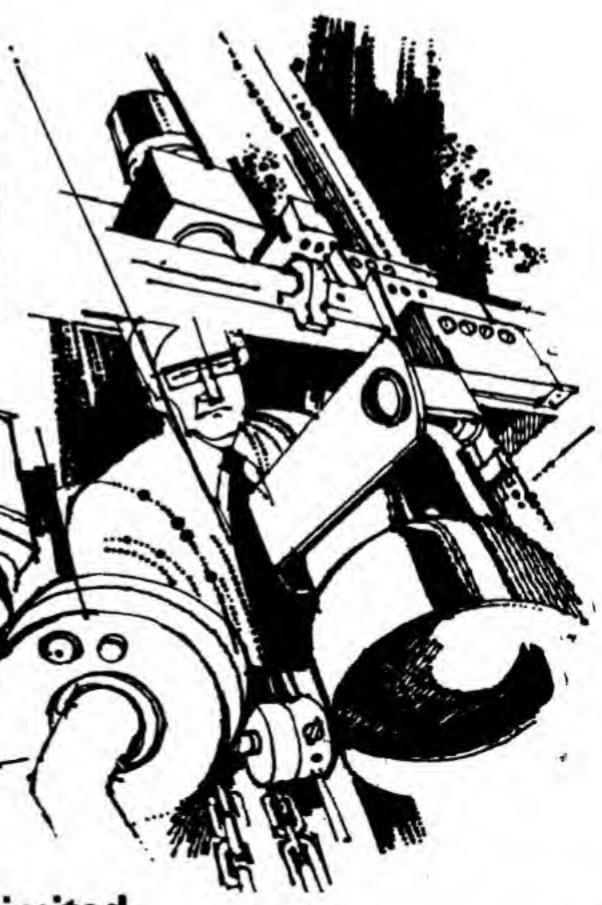
OL technology takes us on to tomorrow.

Oxygen is the breath of life. To the Medical Wing of IOL it is a commitment to produce the best and the latest in anaesthetic and resuscitatory equipment. To supply the purest medical gases to the country's hospitals.

IOL technology doesn't mean industrial gases alone, but the most reliable anaesthetic equipment and incillaries available to the medical profession today—humidifiers, nebulicers, flowmeters, pressure valves, gas manifolds, emergency oxygen resuscitators—IOL technology keeps bringing the latest international developments and innovations in medical equipment to India.

In fields as diverse as steel-making and food preservation, metal joining and fertilisers, electronics and anaeshesia, space rocketry and pollution control—IOL is working today to levelop the technologies the country will need tomorrow.

IOL is life



Indian Oxygen Limited

10C-228

SCIENCE REPORTER

WHAT AURORA IS

CIENCE TO CATCH CRIMINALS

LTERNATIVE TO SEX ?

OCEANS EVOLVED

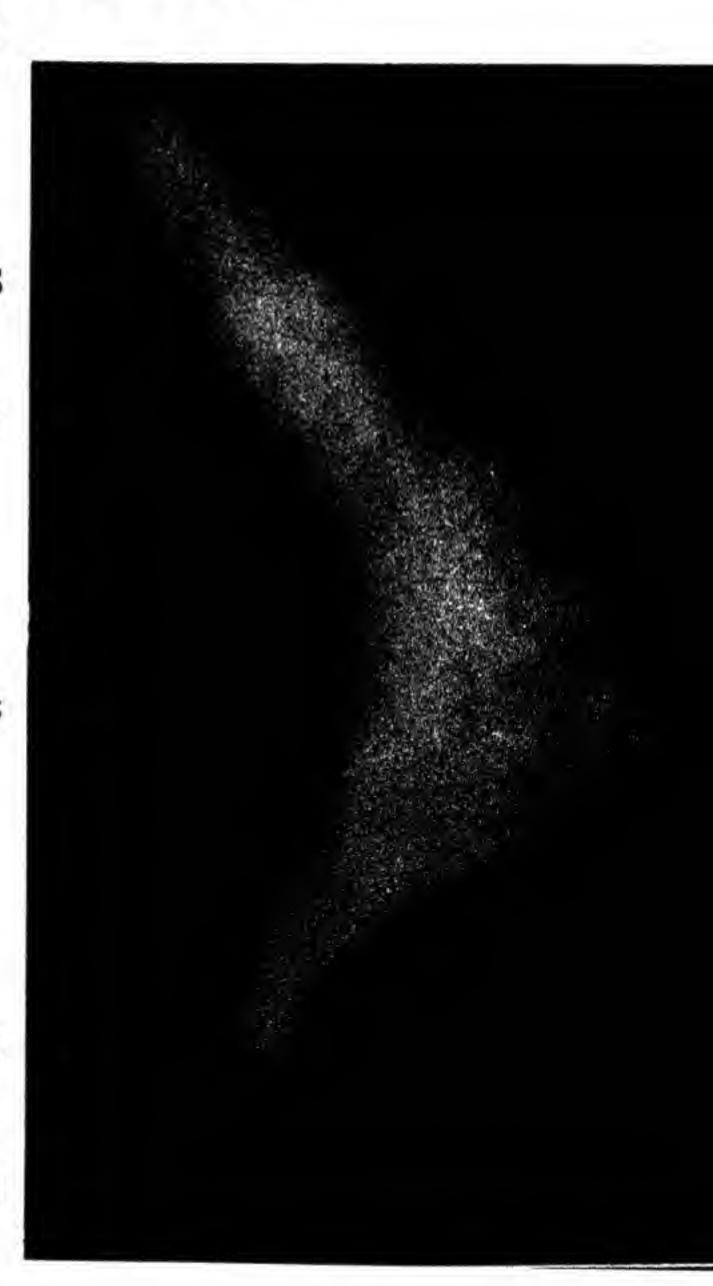
ENOPAUSE FOR MALES?

ET US SAVE INDIAN CROCODILES
AND BLACK BUCKS



Re. 1.00

COUNCIL OF SCIENTIFIC NDUSTRIAL RESEARCH



NATION REGAINS SPIRIT OF ADVENTURE 1975-76

New Deal For Youth

- Essential articles at controlled prices reach 10,490 hostels benefiting over 956,000 students.
- Supply of white printing paper at concessional rates brings down prices of textbooks and exercise books.
 88,600 book-banks functioning in colleges and schools.
- 103 trades and 216 industries now under apprenticeship schemes.
- 18,800 seats added, bringing total to over 133,900 under apprenticeship schemes; 128,900 have been utilised, with 28,000 (over 20 per cent) going to Scheduled Castes, Scheduled Tribes and other backward classes.

BOOKS FOR COMPETITIVE EXAMS.

Career Books		General English	
Suniti's Pattern Book for		Varma's Essay for the I.A.S.	
Science Talent Search Exam.	20.00	by Shakti Batra	15.00
Suniti's Comprehensive Book for I.I.T	. 15.00	General English for Competitive Exams. How to Write Effective English	12.50
Suniti's Medical Colleges	33.00	by Shakti Batra	15.00
Admission Guide	20.00	Guide to Precis Writing	5.00
Managerial Aptitude Tests	10.00	Art of Better Speaking and Better Writing	6.00
Encyclopaedia of General	20.00	How to Study, to Make Notes	4.00
	10 00	Common Errors in English and How to	1115.5
Knowledge and World Affairs	18.00	Avoid them	5.00
Guide for Admission to Medical		Varma's Book of Idioms and Phrases	5.00
Colleges by Major Jodh Singh	18.00	College Essays by Shakti Batra	7.50
Super Intelligence Tests	4.5	Dictionary of Proverbs, Literary Gems,	
by Major Jodh Singh	10.00	Idioms and Phrases	6.00
	10.00	English Literature	15.00
General Knowledge, Current Affairs,		Essays, Precis and General English	6.00
Interviews and Who's Who	4.00	Spot Essays by B.N. Ahuja	12.50
—do— (Hindi)	3.00	Top Essays	15.00
G.K. for Competitive Exams.	6.00	Practical House Keeping by N.N. Kapur	7.50
Successful Interviews	10.00	Humorous Quotations by J.S. Bright	4.00
Modern Interviews by Shakti Batra	6.00	Best Quotations for All Occasions	5.00
Guide to Railway Service Commission Exar		333 Great Indians	5.00
Guide to Banks' Recruitment Tests	6.00	Gandhi's Teachings by Shakti Batra	6.00
Guide to Probationary Officers' Exam.	15.00	Letters	0.00
Guide to I.A.S. Exam. (Solved Papers)	18.00	1000 Letters	6.00
Guide to Indian Forest Service Exam.	12.50	Modern Business Letters	6.00
Guide to Clerks' Grade Exam.	9.00	Modern Letters	5.00
Guide to Assistants' Grade Exam.	18.00	Love Letters	5.00
Guide to Commissions in the Armed		Hindi	5.00
Forces by Major Jodh Singh	7.50		12.50
Guide to Combined Defence Services' Exa	m.	Samayik Nibandh by Prof. Ram Lal Varma	5.00
Vol. 1 for Short Service Commission		Subodh Hindi Nibandh	5.00
by Major Jodh Singh	15.00	Patra Lekhan Kala	5.00
Guide to L.I.C. Officers' Examination	18.00	Business Management	12 50
Guide to Group Discussions	7.50	Practical Business Management	12.50
Guide for Admission to Army Cadet		Office Procedures and Drafting	12.50
College and Army Higher Secondary		How to Negotiate, Bargain and Enter	24 50
Exam. by Major Jodh Singh	22.50	into Collective Agreements	24.50
Multipurpose Objective Arithmetic	1000	Stores Procedures (Materials Manage-	25.00
by Major Jodh Singh	7.50	ment) by N.N. Kapoor	25.00
Varma's Guide to Stenographers'		Varma's Ready Reckoner	5.50
Exam. by O.P. Varma	9.00	History	
I.Q. Made Easy by J.B.S. Aurora	5.00	Indian History (Hindu Period)	12.50
Popular I.Q.	5.00	Indian History (Medieval Period)	12.50
Improve Your I.Q. by J.B.S. Aurora	6.00	Indian History (Modern Period)	12.50
Scientific Knowledge	5.00	British History (Tudor Period)	9.00
Assistants' Grade Arithmetic by Sushil		British History (Stuart Period)	9.00
Kumar and M.M. Sharma	6.00	British History (Hanover Period)	9.00
Constitution of India with Comments	0.00	History of India Maps (All Periods)	9.00
and Criticism	7.50	History of Europe in Maps	9.00
Constitution of India (Hindi)	7.50	History of Britain in Maps	9.00

Packing and Postage is charged extra on small orders.

FREE Postage on every order of Rs. 50/- and above.

Ask your book-seller or send your orders to:

VARMA BROTHERS

21, SHANKER MARKET, P.B. 531, NEW DELHI-110001

to our contributors

- SCIENCE REPORTER welcomes articles of absorbing interest on science and technology. Contributions
 published in the Journal will be paid for.
- Articles should be sent to the Editor, SCIENCE REPORTER, CSIR, Rafi Marg, New Delhi-110001.
- The form and manner of presentation of the subject should be easily understandable to the undergraduate level.
- The length of the article, written exclusively for the Journal, may be about 2500 words.
- The matter should be typewritten, double space on one side of the paper; the original and a carbon copy are to be sent.
- The article should preferably be illustrated; captions and legends typed separately and attached at the end of the article. Photographs should be on glossy paper.
- While quoting names of scientists, etc., their initials, nationalities and periods of research under reference should invariably be mentioned. All weights and measures should be given in Metric Units.
- A short note about the contributor should also accompany the article. The note should contain age,
 academic accomplishments, important assignments held, fields of research and hobbies.
- Articles or illustrations published in the Journal can be reproduced with permission of the Editor.
- The Editor reserves the right to reject even invited articles without assigning any reason.

SU	BSCRIPTION
FO	RM

To

The Editor
SCIENCE REPORTER
C.S.I.R., New Delhi-110001

Name	
Full Address	
(in capitals)	
PIN	
(Old Subscription No)	Signature
NOTE: Please mention old Subscription No. in M.O. e	oupon aleo.

SCIENCE REPORTER

VOL. 13 SEPTEMBER 1976 NO. 9

516 LETTERS

518 PLANETS AND THEIR POSITIONS—OCTOBER 1976

MAIN ARTICLES

519 What Aurora is like R.N. Srivastava

524 Retinal detachment can cause blindness-II Bijayananda Patnaik

527 Why do chamical reactions occur? Y.K. Gupta

532 Science detects crime H.L. Bami

539 Save the crocodiles Lala A.K. Singh

563 SCIENCE SPECTRUM

Solar system-origin and smaller bodies—The discovered 'monopole' on trial—Evolution of continents and oceans—Plants are world's natural pollutant sink—Alternative to sex?—The woman behind DNA scene-Rosalind Franklin—Bacterial flagella—The hydrogen bond—Fluorocarbons are dangerous to atmosphere—Chromosomal aberration and associated diseases in man—Black buck—India's beautiful antelope

566 NEWS AND NOTES

Is there a real menopause for males?—Nobel biologist Monod passes away

567 MEDICAL NOTES

Zinc, its importance to human health—Harmful effects of VCM on fetus— SIDS, the killer of infants

569 SCIENCE FOR THE YOUNG

The strange world of viruses—Problem solving with computor—Oddities in mathematics—Science crossword puzzle (minerals)

574 SCIENCE IN INDUSTRY

Making mines safer-Rain gauze telemetry system

575 BOOK REVIEWS

Soil Microbiology—Development of the Frog—The Microbiology of the Atmosphere—A Text Book of Animal Physiology

Annual Subscription

Science Reporter is based mentily.

The Council of Scientific & Imhestrial

for the statements and advanced by contributors.

Inland : Rs. 10.00

oreign : \$ 5.00

Editor: S.P. Ambasta Austr. Editors: C.B. Sharma, Zaka Imam Editorial Staff: Dilip M. Salvi, Nisha Misra Sales & Advt.: G.N. Jaswal, G.E. Salpeka Production: V.S. Chatervedi



Sir, Thanks for the article Sulpher for plants by N.S. Dhillon and S.S. Bhinder (S.R. March, 1976). I want to add that organic sulphur is made vailable to plants through biological exidation. Sulphur is transformed from the organic form to the ulphate ion by the activity of certain nicroorganisms. Plants absorb the element in the form of sulphate ions. Firstly, sulphur is oxidised by soil nicroorganisms. Organic sulphur is xidised both by soil microorganisms and sulphide minerals such as ferrous ulphide. In soil where good aeraion, moisture and suitable temperaure are available sulphide can be hemically oxidized to elemental ulphur. Elemental sulphur is then xidised to sulphate by sulphur acteria. This was demonstrated by Viklander et al. as follows: $FeS+H_1O+HO_1\rightarrow Fe$ (OH)₁+S S+2H₂O+3O₂ Biological oxidation →2H₂SO₄

> K.S. YADAV Deptt. of Botany D. S. College, Aligarh

Parity non-conservation

Sir, About Parity non-conservation

he sulphate ion is taken by plants

s replacing hydroxyl ions in clay

ninerals, a process known as anion

xchange.

nd weak interactions by Tapash hakraborty (S.R. March, 1976), I ould like to add the following. In the experiment conducted by ime. Wu and others, for lining up e spin of beta emitting nuclides, e sample was actually cooled to K by liquid helium and further d below 0.01 K by adiabetic

demagnatisation process and not to 0.01°C as mentioned. The determining of beta particle emission more in the direction opposite to that of the nuclear spin is experimentally a difficult feature. This was solved ingeniously by Mme. Wu et al. by exploiting the assymetric gamma emission when the beta spins are lined up.

> R. RADHAKRISHNAN Madras Christian College Madras

Air pollution and lung diseases

Sir, My attention is drawn to the article Air pollution and lung diseases (S.R. January, 1976, p. 9). Earlier, Pollution by pesticides by H.C. Joshi (S.R. October, 1975, p.492); Effect of pollution on weather by P.S. Harihara Ayyar (S.R. Nov., 1973, p. 518); and Some environmental polintants by S.N. Sinha and P.R. Mitra (S.R. January, 1976, p. 38) were described in series. Now the common pollutants like carbon monoxide, sulphur dioxide and others have found place in the recent article on air pollution and lung diseases, but unfortunately, how carbon monoixide has led to death of the living being due to suffocation was not well brought out.

Usually, haemoglobin which contains iron picks up readily oxygen in the lungs to form oxy-haemoglobin in which oxygen is loosely held to the iron atom in the haemoglobin. The cycle of oxy-haemoglobin transportation from the arteries to the capillaries and then to tissues continues. But, if carbon monoxide present in the air is inhaled, no oxyhaemoglobin is formed. Haemoglobin now combines with carbon monoxide to form the carbonyl compound which is about 400 times more stable than oxy-haemoglobin. Once haemoglobin combines with carbon monoxide, the oxygen transportation cycle is no longer possible That explains the ultimate decay of the living being by moans of suffocation.

In fact, chemistry plays a vital ro in environmental pollution.

> P. C. BHATTACHARYY Vidyasagar Colley 39, Sankar Ghosh Lan Calcutta-7000

Papaya (S.R. Feb., 1976)

Sir, Will there be any bad effe on our body if raw latex (one two drops) is continuously swallowe with water over a long period

> SWAPAN KR. BANERU Kamangaria (W.B

Such studies have not been mad on human system. It is difficult t predict about precise effects of th latex on millions of reactions taking in our body. Howeve place latex of papaya is known to improv appetite and correct the malfund tioning of liver. It has a goo effect on a person suffering from jaundice.

> D.K. JAI Deptt. of Botan Meerut College, Meeru

Fuel cells (S.R. March, 1976)

Sir, The author compares fue cells with secondary batteries and mentions that in fuel cells 'the fuel and oxidant are all gaseous' This is not correct and greatly limit the potentiality of the highly efficien energy source of tomorrow. Fue cells using hydrazine (liquid) as fue are well-known and the first practical fuel cell experimented by Ostwald used carbon as fuel. Similarly liquid oxidants like hydrogen peroxide or chlorine can be used in fuel cells Methanol is also being tried as a fuel. India, a major sugar producing country, has plenty of molasses from which alcohol is produced. Alcohol can be used as a fuel.

Other than the advantages mentioned by the author, I would like to add J.O'M Bockris' words: "The aluable hydrocarbon store of ature 'oil, coal and natural gas' ould be used to clothe and feed ne third of the population which t present suffers from malnutrition and want, instead of burning them to get energy." Fuel cells provide ne solution.

> G. JOTHINATHAN Metallurgy Deptt. Indian Institute of Tech. Madras

Animal migration

Sir, In Why do animals migrate? y B.B. Jana (S.R. March, 1976) othing has been mentioned about ying ducks which migrate to ashmir valley in winter months om as far as Siberia.

How migratory birds find their ay is one of the great ornitholoical mysteries. How do the birds eep to their course that stretches lousands of kilometres across the ontinents? It has been theorised nat the birds carry a mental map f the landscape they fly over and impensate for wind drifts by contiuously checking with what they ce below. Other theories suggest ther a "wind sense" or a bio-inertial nechanism possessed by the birds. the latter were true, the birds ught to be able to make equally orrect compensation while flying ver the sea as over land. But, pparently, they do not.

An answer to this inability has een provided by two Swedish rnithologists T. Alerstam and Patterson from Lund. They used adar data to study the flight paths of cranes, wood-pigeons and redvings over both land and sea. It eems the birds do follow a visual rack and line up with the wave patterns and irregularities in the ame way as they do with land eatures. But because wave patterns

are not fixed (due to the sea's motion), the birds fail to achieve complete compensation for wind-drifts while flying over the sea.

> MAHARAJ K. KOUL 2, Sanat Nagar, Srinagar-190005

> > 11

Sir, Why do animals migrate? (S.R. March, 1976) by B.B. Jana was a good article, though it contained some inaccuracies.

During migration, some birds fly at a speed greater than 80 km per hour. Speeds upto 94 km have been reported (Carthy, 1956).

Gulls migrate not only to their favourite lakes but they do so mostly to the western and eastern seaboards of India. They migrate not only from Mansarovar in the Himalayas but also from many other lakes in the Himalayas, and from Tibet and Ladakh (Salim Ali, 1972). Flamingoes do not migrate from Mansarovar as reported, but are resident in India. Migration from outside India takes place on a small extent (Salim Ali et al., 1968).

India has a number of cuckoos, both resident and migratory. Only one species, the pied crested cuckoo, Clamator jacobinus serratus, is a vistor during rains, presumably from Africa (Salim Ali, 1972). This is the legendary species eulogised in many songs as chataka. We receive this bird in the New Forest area in Dehra Dun. Never has it been observed laying eggs in a crow's nest as is the usual habit of a different cuckoo, koel, Eudynamys scolopacea. It has been found parasitising on the nests of common babblers.

Altitudinal migrations occur in many mammalian and bird species of India in the Himalayan region. For instance, the Himalayan black bear migrates to heights of upto 3660 m and comes down to comfortable levels of 1525 m (Prater, 1971) We receive at Dehra Duna number of Himalayan birds during their course of altitudinal migrations; for example, Himalayan tree pie, whistling thrush, etc.

Population of bison (Bison bison is not in millions as reported but it less than a million now.

SHAILENDRA SINHA Lecturer in Forestry and Wildlift Indian Forest Colleg PO New Fores Dehra Dun-24800

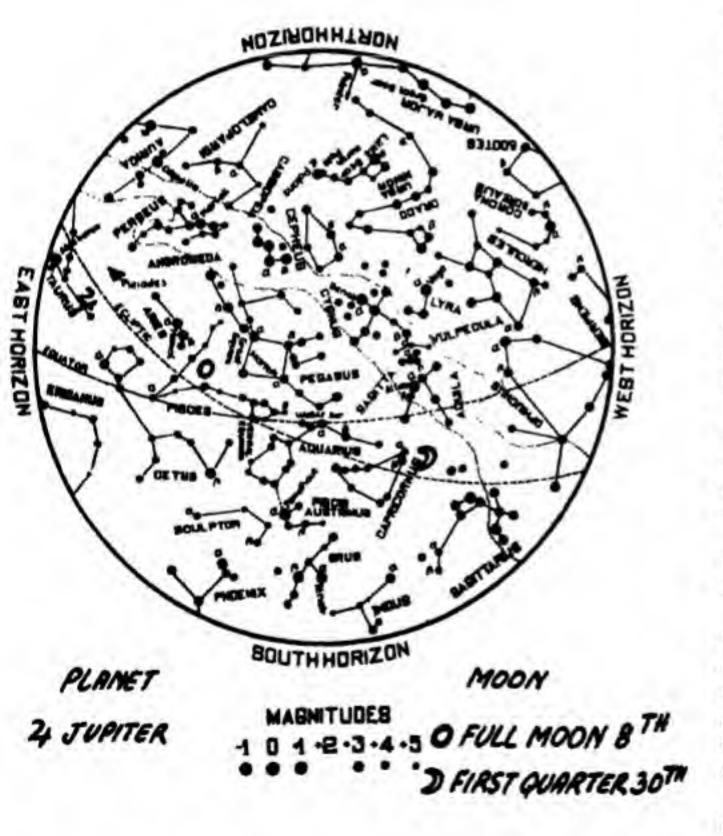
Neem as a medicinal plant

Sir, I read the article Neem as medicinal plant (S.R. February, 1976 with great interest. The review con tained the work of S.P. Basak an D.P. Chakraborty on the isolatio of beta-sitosterol and quercetin from the green leaves of the plant, quer cetin being associated with anti bacterial and anti-fungal action. Un fortunately, neither there was men tion about the constituents of th trunk bark of Melia azadirachta Linn. (called neem) of current inte rest nor there was any provision fo the contribution of the other chemists Khuda et al. (JICS, 1940, p. 189), Se and Banerjee (JICS, 1931, p. 773) to the field. Nimbiol, a keto pheno lic diterpene (m.p. 250°C-257°C formula C18H24O2) wa chemical found to be present (Sengupta et al. Tetrahedron, 1960, 10, 45) along with sugiol, a 7-keto ferruginol in the alkali soluble benzene fraction. Be cause of considerable interest on the phenolic diterpene, the present worl should cover the contribution o the chemists on the investigation o bitter principle of the neem of explaining how diabetes is controlled by the use of the latter.

P.C. BHATTACHARYY.
Vidyasagar Colleg
Calcutta-70000

Planets and their positions

OCTOBER 1976



The moon

a.m. and new moon on 23rd at 0-40 a.m. 1.S.T. The moon passes bout a degree south of Jupiter on 2th, six degrees south of Saturn on 8th, about three degrees south of

Mercury on 22nd and four degrees north of Venus in the evening of 25th. The lunar cresent becomes first visible after the newmoon day in the evening of 24th.

The moon is at apogee or farthest from the earth on 10th and at perigee or nearest to it on 23rd.

Solar eclipse

There will be a total eclipse of the sun on 23rd. The eclipse wi be visible in parts of southern Indi and Sri Lanka as a partial sola eclipse.

The planets

Mercury (Budha), a morning starises about an hour before sunrisduring the first three quarters of the month. Thereafter, it is too near the sun to be visible. It become direct on 1st and is at the greates western elongation of about 1 degrees from the sun on 7th. I moves from Leo (Simha) to Libr. (Tula) through virgo (Kanya) be direct motion. Its visual magnitud varies from +0.9 to -1.0.

Venus (Sukra), an evening starsets about one and a half hours after sunset during the first half of the month, and about two hours after it during the second half. It passes about three degrees north of the star Antares (Jyestha) on 28th. It moves from Libra (Tula) to Scorpic (Vrischika). Its visual magnitude is about -3.4.

Mars (Mangala), is too near the sun to be visible during the month It is in Libra (Tula).

Jupiter (Brihaspati) rises about two and a half hours after sunse during the first half of the month and about one and a half hour after it during the second half. It is in Taurus (Vrisha). . Its visua magnitude is about -2.3.

Saturn (Sani), visible in the morning sky, rises about one hour after local midnig it during the first half of the month and about half hour after it during the second half. It is in Cancer (Karkata). Its visual magnitude is about +0.6.

(Source: Nautical Almanac Unit of the Meteorological office. Alipore Calcutta-700027.) Auroras do not appear in the skies of the regions where nost people live. Even today not one theory accounts for all auroral phenomena

A LARGE variety of colourful nocturnal scenarios often ppear on the high-latitude upper tmosphere (100-400 km) in both emispheres. They are commonly termed as draperies, ribbons, omogeneous quiet arcs, rayed bands, olds, loops, patches, and surges, etc., ut they all come under the domain f aurora.

Although aurora is visible to the aked eye only in the dark hours it , in fact, a continuously occurring henomenon of the earth's environnent. The shimmering and flaming of his natural phenomenon in different hases can be seen over the olar night sky. It is rather nfortunate that such vigorously eautiful displays of nature do of appear in the region where jost people on the earth live. For us reason, perhaps, the true 'global' mentific cooperation and appreciaon of the auroral phenomenon had cked for a long time, and the early tempts to unfold its mysteries were rief and sketchy until more intensive nd coordinated IGY (International eophysical Year) programmes were unched in the late fifties.

istorical background

Auroras have been studied and ported since the early 1600 by many propean workers like M. Gassendi, Halley, D. Mairan, E. Loomis, Fritz, K.K. Birkeland, C. Stornier and E.H. Vestine. However, within the last two decades alone, a tremenous amount of research has been

done which has led us to a better understanding of the auroral phenomenon. The research was carried out by the use of ground-based all-sky camera photography, photometric and spectroscopic observations in combination with the information acquired through sensors and detectors flown in aircrast, rockets and artificial satellites. The mapping of the entire polar region thereby revealed a great multitude of auroral forms and types. The auroral morphology is now more properly understood.

Auroral oval

An important large-scale feature of the auroral studies is to locate precisely the zone of occurrence of the aurora. It was believed earlies that the auroral light appears within a circular auroral zone about it wide around ± 65° geomagnetic lattude, where the frequency occurrence of aurora was found to be the maximum. However, as we know it now, the seat of aurora occurrence is not confined to the auroral zone.

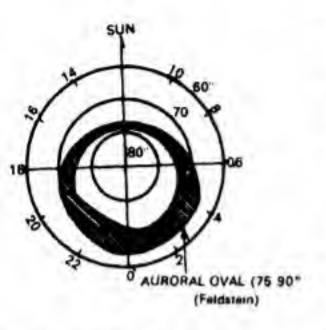
In 1963, a Russian scientist, Y. Feldstein had noted the zone of auroral occurrence as an oval-shape belt which encircles the earth's magnetic poles and called it the aurora oval. Configuration of the oval zone, as sketched by Feldstein, shown in Fig. 1(a). It clearly

R. N. SRIVASTAVA



WHAT AURORA IS LIKE

Dr. Srivastava teaches physics at the University of Papua, New Guinca, Port Moresby.



the auroral oval g. 1(a). Location

ndicates that the oval coincides ith the nearly circular auroral one only at the observer's local nidnight. Elsewhere, it falls inside he auroral zone.

Fig. 1(b) illustrates some important gions of the magnetosphere which re linked with the auroral phenonena. The trapping region [Fig. 1] is he inner magnetosphere, where the eomagnetic field lines are closed nd where the energetic particles electrons and protons) are trapped. he outer magnetosphere is the gion of the open geomagnetic field nes. Clearly then, the auroral oval an be seen as the projection of the oundary of the trapping region and he outer magnetosphere on the olar atmosphere. The oval is found be eccentric because the trapping egion is asymmetric with respect to he dipole axis.

Recently, the existence of the oval elt has been confirmed by auroral hotographs taken directly from SIS and DMSP satellites. Records lso indicate that the size of the oval hanges considerably with the solar ctivity. The oval, in fact, expands apidly towards the equator during ne magnetic storm. Therefore, it is uite likely that the aurora is visible t lower latitudes during large magnec storms.

roduction mechanism of aurora

Aurora is produced in the atmoshere as a result of a complex series of inter-related solar-terrestrial physical processes. In general, it comes as a consequence of the interactions between the electrically charged particles streaming from the sun and the atmospheric constituents. The particles taking part in the interaction are electrons and protons and the atmospheric constituents are mainly those of oxygen and nitrogen. The primary processes responsible for the production of auroral luminosity are direct collisional excitation [Eqs. (1) and (3)] and ionization of atmospheric gases by electrons and protons. The equations governing such interactions can be described as follows:

$$e + X \rightarrow 2e + X^{+*}$$
 ..(2)

$$H+X \rightarrow H^{\bullet}+X^{\bullet}$$
 ..(3)

pheric constituent.

Auroral lines

Combinations of different colours in the aurora are essentially due to radiations emitted by the excited or ionized constituent atoms or molecules. For example, the most conspicuous green and red colours the aurora are due to excited oxyge atoms at the respective wavelength 5577A and (6300, 6364) A lonized nitrogen molecules em intense light, particularly violet an blue, in a group of spectral band between 3914-4700A, whereas excite nitrogen molecules account for th deep red colour of the aurora in th wavelength band between 6500 6800 A. In addition to the above there is another faint red light of th aurora which is due to radiatio emitted by excited hydrogen atom in decaying to lower levels. Thes lines form the Balmer series of spectral lines. Some of the importan auroral lines are shown in Fig. 2.

Auroral classification

Auroras have been classified in th literature either in terms of thei colour or their luminosity. Two dis tinct types according to their colou are the type A and type B aurora which occur at different altitudes Oxygen radiation at 5577A and nitrogen radiation at 3914Å originate predominantly at 110 km and is the type Baurora. The red lower borde

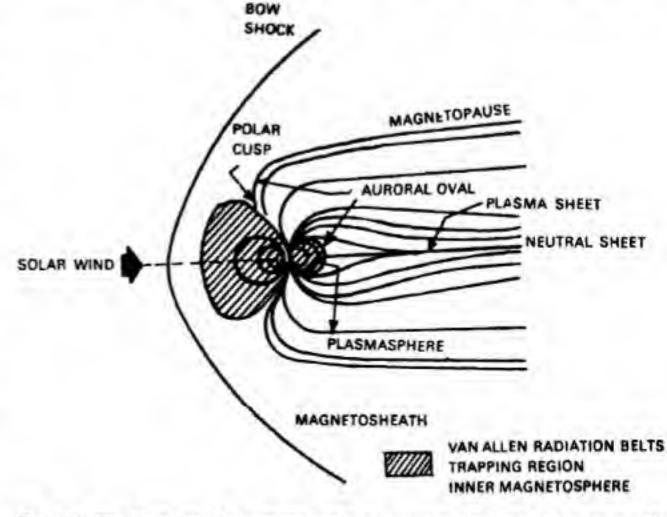


Fig. 1(b). Configuration of the geomagnetic field (magnetosphere) in the noon-midnight magnetic meridian plane. Shaded region contains the region of closed fiel lines at whose boundary auroral oval is located

of type B auroras is due to molecular emissions at lower altitudes which come from the enhancement of N, irst positive (6400-6800) A or O,+ irst negative bands (5600-6000) A.

Luminosity classification is according to the brightness produced in the mission of the 5577 Å radiation. The auroral brightness in kilorayeighs (I rayleigh=10° photons/cm³. ec) may vary anywhere from the isual threshold to as bright as the ull moonlight. Accordingly, the mission rate of 5577 Å line intensity the IBC (International Brightness Coefficient), I, II, III and IV aurora 1, 10, 100 and 1000 kilorayleighs espectively.

orms of aurora

It has been observed that auroras sually appear in two different forms. or example, it could either be a iscrete aurora which has bright arrow stripes of luminosity and is eparated by dark spaces of finite yidth or it may be a diffuse band of uminosity having non-uniform rightness. The diffuse aurora is sually found to be located equatorard of the discrete auroras. It ppears as a singly connected oval elt and remains present even during erv quiet periods when discrete

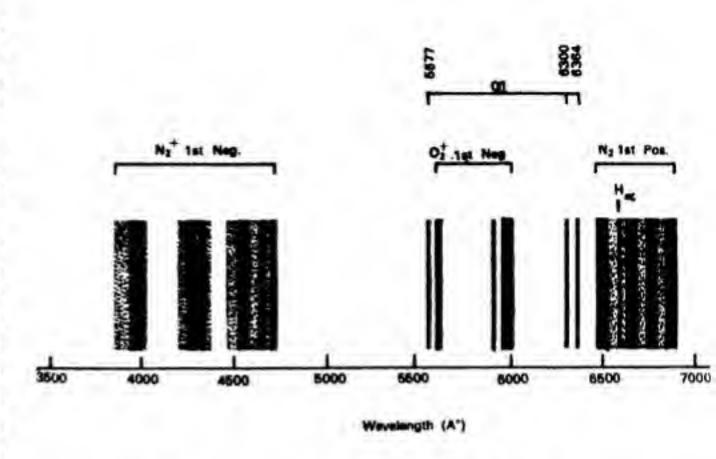


Fig. 2. Spectrum of the aurora-some prominent lines

auroras become almost invisible. The discrete aurora is found to be essentially an evening feature. Fig. 3 shows a photograph taken from DAPP satellite which indicates the relative placings of the discrete and diffuse aurora.

Auroral structure and magnetic activity

Basically, the structure of the discrete aurora happens to be ribbon-like called the homogeneous quiet arc. This structure

generally consists of one or more thin arcs stretching east to we from horizon to horizon with dimer sion of at least a few thousan kilometers. The thickness of the ribbon is not more than a few hundre meters. Periodically, the ribbon like configuration develops striation and convolutions with the increase of magnetic activity. If the magnet activity keeps increasing, other structural forms like bands, folds an loops also evolve with successival brightening and movement. How

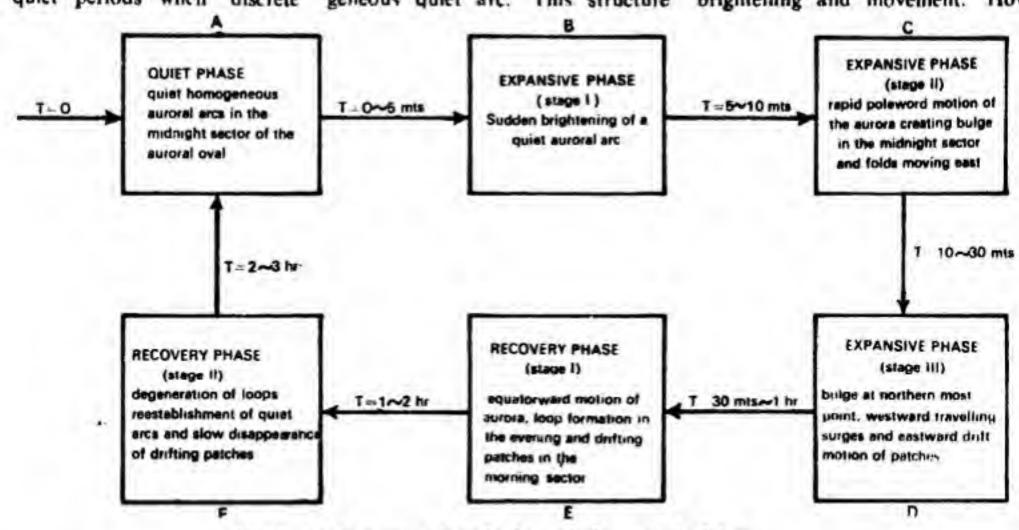


Fig. 4. Block diagram of the development of an auroral substorm



g 3. A photograph of the naroral oval in the dark bemisphere taken from DAPP satellite at about 2123UT on 25 January, 1973

ver, if there is not much magnetic ctivity, the auroras would disappear without brightening and break up into cloud-like patches.

recipitated particles

Contrary to what was believed arlier, it has now become increasngly clear that the midnight auroras re caused by particles of solar origin which are intially stored in [Fig. 1 (b)] is the region of charged particles beyond ten earth radii on the night side and may even extend up to a hundred or more earth radii. From the plasma sheet the particles can be accelerated to energies of a few tenths of keV to a few tens of keV. This happens when the particles gyrate around the magnetic field lines and come from

the low magnetic field strengt towards the high magnetic fiel strength side. In other words, the magnetic field lines collimate an energize the particles from the plasm sheet to impinge on to the high latitude upper atmosphere.

The dayside auroras, however, as formed by soft particles, i.e., which have energies of about 100 eV for electrons and a few hundred eV for protons. The soft particles ente the polar atmosphere directly through the dayside polar cusp [c.f. Fig. 1'(b) as is evidenced by the presence of 6300 A emission in the daysid auroras. The flux of precipitate electrons at all the energy range has been found to increase marked with increase in the magnetic activity However, strong electron fluxes occu on the night side in close associatio with the aurora and the particl energy increases upto several kild volts with decreasing latitude.

Sabsterm process

It is well established that the sur is continuously pumping out it plasma, a part of which flows toward the earth and helps to maintain the steady-state configuration of the magnetosphere during normal time. However, when the sun become active, intense flows of solar plasm disturb the steady-state situation and its after-effects are felt globally some times even for days.

According to one phenomenolo gical model proposed in 1973 by team of American scientists heade by R.L. McPheron, the high variab lities in the continuously flowin quiet-time solar wind erode th magnetic field from the front of th magnetosphere and convect it to th tail. The eroded flux is not imme diately returned but builds upon th nightside until the energy reservo in the magnetotail (antisunward sid of the magnetosphere enclosing th plasma sheet) attains its full capacit to give rise to several short-in a explosive processes within the magne osphere. Auroral substorm phenonenon is such one dynamic which rocess releases and issipates a large amount of energy tored in the nightside of the nagnetosphere following a major olar storm. Just to quote a simple xample, the total energy injection ate for the fairly bright auroral isplay, say for a 100 kilorayleigh of 914 A emission in the aurora, is f the order of 120 ergs (cm2-sec)-1.

uroral substorm

Various phases of an auroral ubstorm can be briefly described as sequence of systematic and characeristic auroral displays which ori giate in the midnight sector of the uroral oval. The substorm has a pical life-time of the order of one three hours. Complete sequence f auroral substorm phases is illusrated in Fig. 4. The illustration is ased on a detailed study of all-sky amera data by an American scientist, I. Akasofu, in 1964. First of all, s the magnetic activity increases, the val expands as far equatorwards as ossible, taking the quiet auroral rcs to lie along with it. The first ndication of the visual onset of the uroral substorm is the sudden acrease in brightness of one of the outhernmost arcs in the expanded val. Soon its effects spread iolently in all directions, breaking p the other pre-existing arcs and ausing poleward expansion, westard travelling surges and eastward rifting patches in different local me sectors. As the substorm actiity subsides, the scattered auroral ragments converge slowly and ressemble into quiet homogeneous rcs tracing out the auroral oval as was before the substorm.

quatorial current system

Concurrent to the auroral phenoiena, the ground magnetograms of igh latitude stations often show arge magnetic variations. Variations the horizontal component of the

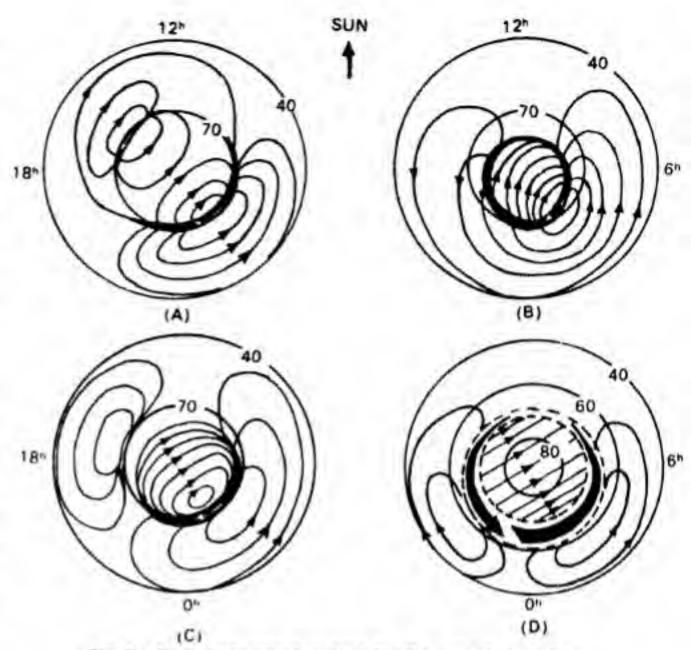


Fig. 5. Equivalent current systems for the auroral electrojet

magnetic field are called bays because they resemble a topographical bay. It is widely believed that during these substorm magnetic perturbations, which are associated with auroral activity, intense electric currents known as auroral electrojet flow at the high-latitude E-region heights. The electrojet current is best ordered when considered as aligned along the auroral oval. Fig. 5 schematically shows four equivalent current systems which are being frequently discussed in the literature. A common feature of all four systems is a high concentration of westward electrojet in the 2200-0600 time sector. Three of these systems, however, also show an eastward electrojet in the evening.

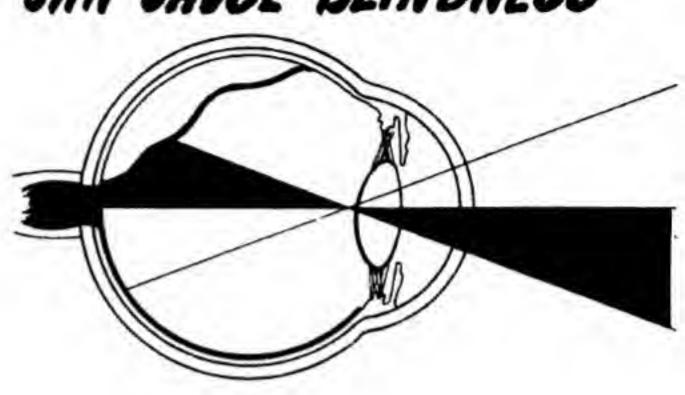
Current closure is shown to occur at lower latitudes and over the polar cap. Although closure of actual current flow is probably not confined to the ionosphere, it is thought that westward electrojet is ionospheric in character. Eastward electrojet current may be connected to asymmetric ring current through field-aligne currents.

Conclusion

All the assembled features of the midnight aurora tend to indicate that it may be caused by an instabilit which is non-linear and explosive occurring in a confined region of th magnetosphere. This is so because the region where the instability se in can remain inactive for hours t give rise to stable homogeneou arc but becomes activated in a feminutes. The problem is, thus, t sort out all the known plasm instabilities and to find their relevance or irrelevance to the auroral an associated polar geophysical pheno mena. Although several mechanism have been proposed in the past t explain different auroral features an the numerous other observation associated with the aurora, what w still lack to date, however, is a sing most comprehensive theory which can satisfactorily account for all th observed auroral phenomena.

BIJAYNANDA PATNAIK

RETINAL DETACHMENT CAN CAUSE BLINDNESS



s it possible to prevent retinal letachment? Yes, it is. A letachment? Yes, it is. A leatient must rush to consult retina specialist on the ppearance of first symptoms

THE age old adage 'Prevention is better than cure' is perhaps owhere more appropriate than in ase of retinal detachment. The are of retinal detachment involves very delicate, time consuming peration (about 4 hours) under eneral anaesthesia. Besides the sks of operation there is an ineviable small risk of anaesthesia. It true that the prospects (prognosis) f success have increased from some 0% a decade back to about 80% oday. Yet, even the most deliately executed surgery cannot store 100% of the vision. The oment the retina is detached it rinkles. Even if it is reattached nmediately, the retina fails to asme the same perfect smoothness it ad before the detachment. The sult: everything looks a little avy-the sharpness of vision is st for ever. The greater the delay

in treatment the greater is the loss of visual perfection. Also the process of surgical treatment of the retinal detachment involves scarring of areas of the retina with inevitable loss of its function. The most successful surgical techniques in reattaching the detached retina are also somewhat drastic. While such techniques preserve the most important central vision, the peripheral vision is sacrificed. Therefore, it should be obvious that the ideal solution is to prevent a retinal detachment rather than trying to cure it after it has detached. It is just appropriate that the World Health Organisation (W.H.O.) has for its theme for 1976: "Foresight Prevents Blindness".

Is it really possible to prevent a retinal detachment? The answer is, yes. Retinal detachment is not a disease which could afflict just any one. The vast majority are myo pics (short-sighted) wearing thic glasses (high myopics) or member of the family of myopes. The other important groups are those who have got their cataract operations don and those who have been hit and have suffered injuries of the eye. A con paratively small percentage of the patients would slowly develop weal ness (degeneration) of the retina t which the degenerated vitreous wi be attached. Some day retin tears would form. After the tea have formed it takes months, eve years, but rarely days before a retini detachment develops. As such, is not really a sudden accident as appears.

As long as the retina is not detected, the retinal degeneration and even retinal tears can be successfully treated without surgical operations. In other words, if a patient

Or. Patnaik is Asstt. Prof. of Ophthalmology (Retina care) at Maulana Azad Medical College and Associated Irwin and G.B. Panlospitals, New Delhi.



"I see some dots before my eye, Doc."

redisposed to develop retinal dechment with retinal degenerations nd holes happens to come across a ained retina surgeon who on a orough retinal examination detects nese lesions and completes what is nown as a prophylactic (prevenve) treatment, there is no reason hy the patient will develop a retinal etachment. It is possible that fter the first treatment patient may evelop some more of retinal degeeration or retinal holes. This only eans that such an individual must ontinue to get himself examined at gular intervals as an insurance gainst a retinal detachment.

People who are prone to develop etinal detachment (Target populaion) belong to the following cateories:

(a) Myopics (the short-sighted), pecially the high myopes (using lasses of —4 D or more) and rapidly rogressive myopes (those who have change their spectacles frequently), onstitute the largest group (68% f my cases of detachment)

(b) Aphakics—those who have een operated upon for cataract, are he next important group (16%).

(c) Those who had had sustained ajury to the eye (6%).

The majority (67%) of the cases of retinal detachment that we see in this country are between the age proups of 30 to 60 years; of which people between 40-50 years account

for 42% of all cases of retinal detachment. Retinal detachment is much more common in males than in females. Males outnumbered females among my cases at a ratio of 7:3. Greater outdoor and physical activities among Indian males seem to be the most important cause for this difference.

The least these people could do for themselves is to get their retina thoroughly examined by competent retina specialists. The modern retina specialists use with skill such examination systems as indirect ophthalmoscope and Goldmann's 3mirror contact glass, developed over years of painstaking research. Out of these procedures the one which is most useful, hence the most difficult to master, is the indirect ophthalmoscope. Unfortunately, the vast majority of ophthalmologists trained in this country or in Great Britain are poorly trained in the use of this technique. Most of them who hear about its usefulness go as far as acquiring an instrument. The process of mastering the technique is too time-consuming and requires hours of back-breaking practice. Few find the time or the inclination to do so. As a result, there are surprisingly few competent retina surgeons in the country today. However, the younger generation among the ophthalmologists seems to be getting the message. The number of retina surgeons is slowly likely to increase. It is almost totally useless for the purpose of prevention of retinal detachment to consult ophthalmologists (however famous they may be) who are not retina specialists.

To start with, a detailed mapping of the fundus (inside of the eye) is carried out on a special chart. Depending on the nature, the side, and extent of the retinal pathology patients are categorised into different risk groups. The high risk groups with imminent retinal detachment are treated for its prevention

(prophy! ctic treatment). The weak areas of the retina and those with tears are treated by cryopexy (freezing) or photocoagulation, so that the retina surrounding the weak areas or the tears are stuck to the underlying choroid by a scar. The procedures of cryopexy and photocoagulation do not need a surgical operation. However, once a retinal detachment develops, it can be treated only through an operation.

The degenerations or tears (doctors call them lesions) do not develop all at once. It is possible that new lesions continue to develop over a period of time. This would necessarily mean that such patients get themselves examined by a retina surgeon at regular intervals. Retinal tears or degenerations are taker care of as soon as they threaten to develop into retinal detachment. To give an example; there is one patien in our detachment clinic record who developed tears, dangerous ones on five successive occasions. Each time they were detected before detachment developed and treated to make them safe. The system o constant watch and preventive treatment has saved him from detach ment five times. In course of time all sites of vitreous pull reveal them selves in the form of retinal tear or retinal degenerations and ar treated to make them safe. There after, no new retinal tears should develop.

Warning premonitary symptoms

There are certain symptoms which to the patients of the susceptibl group, may mean serious trouble.

1. When a degenerated vitreous shrinks, a time comes when it get detached from the back of the ey and collapses forward to crow behind the lens. While a normal vitreous is transparent and is not visible to the retina, the collapse vitreous may be seen as multiple transfuscent dots dispersed irregularly or in form of chains of various

orms. The chains turn or twist with the movement of the eye.

2. When a vitreous pulling on the ctina causes a retinal tear, often the etinal blood vessels passing across he tear snap and bleed into the itreous. When the bleeding is mall, the patient suddenly sees lark spots which gradually disperse, and may disappear with or without reatment. More extensive norrhages appear as a mist or a cloud. A massive haemorrhage may obscure vision for variable periods. The wise thing to do in uch a case is to take complete ed rest and contact a retina urgeon for a thorough fundus xamination to discover the cause of vitreous haemorrhage. If some one is a myope or an aphakic and s not a diabetic nor suffers from that doctors call Eale's disease, he as almost certainly bled from a etinal tear. Unfortunately most atients, even the majority of examinng doctors and eye specialists, do not ppreciate the significance of the sign. s a result, a retinal break which ould have been successfully treated vithout a surgical operation by hoto-coagulation or cryopexy goes on to cause a retinal detachment.

3. Pull on the retina causes a ensation of light. It may be in he form of tiny twinkling lights or

large, soft glows moving away painlessly and silently. They are known as photopsae. If they appear suddenly, an immediate investigation is required.

4. A beginning of retinal detachment can be perceived as a dark veil or shadow appearing and enlarging. As the detached retina moves and shifts, it gives a sensation of soft glows of light moving and breaking up as they move to disappear.

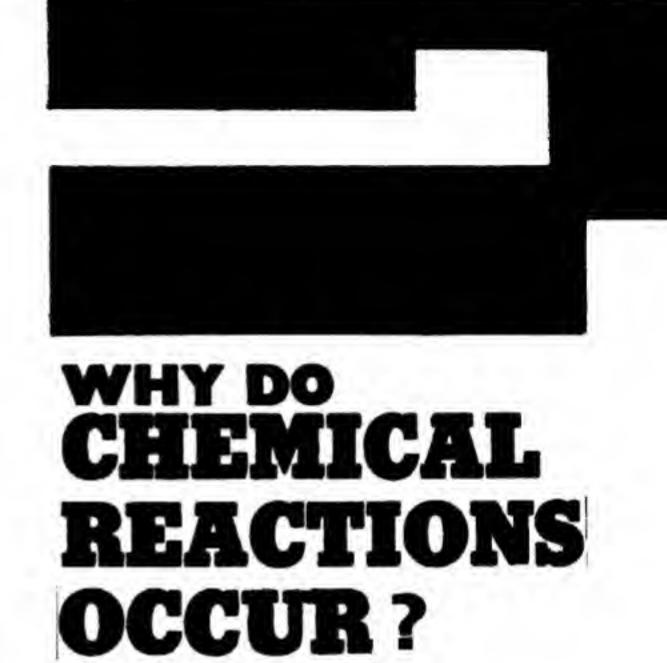
Any one who is susceptible to develop retinal tears and detachments must consult a re na specialist the moment he experiences symptoms similar to the ones listed above. It may be of interest to illustrate the point with a case note. Mr. G., 48 years male, is a high myope. He was examined at the Retinal Detachment Clinic of Irwin Hospital and was found to have got dangerous looking retinal degenerations. He was advised to avoid jerky vehicles, accidental falls, etc. He was also suitably educated on the warning signs indicating dangerous happenings in the retina and kept under close observation for deciding on a preventive treatment. A fortnight later, his nephew acquired a new scooter and invited our friend for a joy ride. In the face of the effusive enthusiasm of his nephew Mr. G.

adventures. While the scooter junped along a bumpy road two large tears were formed in his left eye. blood vessel passing over the tear got torn. Mr. G. saw the all sign ficant "multiple dark spots" in from of his eye. He came straight to a and had to be operated upon with the use of cryopencils in both eyes.

He was thus saved from an imm nent retinal detachment in the le eye. The areas of retinal degenera tion in the right eye were made safe Though the risk of retinal detachmen was drastically reduced by preventive therapy, he was by no means con pletely out of danger from new retine Two months later, on on of his follow-up examinations h showed a newly developed giar tear. This was promptly taken car of by us. Now, for the last two year he has not developed any mor symptoms. However, he would b kept under close observation at ou Retinal Detachment Clinic like man others of his type.

(This clinic where potential cases of retinal detachments are taken care of through continuous survillance and timely prophylactic treatment is unique in this country. Such free clinic are among the best Retina Center in the world. However, considering the pasticity of suitably trained retina specialists the country such clinics in public institution should be encouraged—Editor.)

What is the significance of erms 'reaction occurs' and reaction does not occur'? Reactions can occur both rays, 'occur' and 'does not occur' are in fact misleading erms



THERE is always a question mark in the minds of young underraduate students in regard to the ccurrence of chemical reactions: Why do chemical reactions occur?, What makes the reaction go?', or What is the driving force behind a hemical reaction? Answers to nese questions are not immediately bvious. When a zinc rod is dipped an aqueous solution of copper ulphate, copper is deposited and inc goes into solution. Why does ne reverse process not happen? litrogen and oxygen combine to orm nitric oxide at high temperaire. Why do they not combine a lower temperature? But before e attempt to answer these questions, t us first know what a spontaneous rocess is.

reactions and processes

A spontaneous reaction is one which occurs by itself, without any external agency taking part in it. Combination of carbon and oxygen is a spontaneous reaction. However, our common day observations appear to disapprove this fact. We have plenty of carbon and oxygen around us, but we hardly find any chemical reaction to occur even in years.

The fact is that the reaction is very slow, so slow that it is not perceptible even in years. If we burn (raise the temperature) carbon, carbon dioxide is easily formed. This is equally true of the combination of hydrogen and oxygen where a catalyst is needed to make the reaction fast.

The meaning of spontaneity is no so obvious by chemical reactions. . few physical processes would mak the meaning clearer:

- (1) Water always flows down slope. The process is spontaneous. The reverse process, flowing up the slope, is non-spontaneous. However, a motor (external agency) capump the water up a hill obuilding;
- (2) A piece of elastic rubber, who stretched and left, contracts sponta neously;
- (3) A watch spring unwinds itse without any aid, and
- (4) A piece of chalk, if droppe from the hand, falls to the ground This is a spontaneous process. It does not go up. However, we can throw chalk up with the help of our han

r. Gupta teaches chemistry at the University of Rajasthan, Jaipur

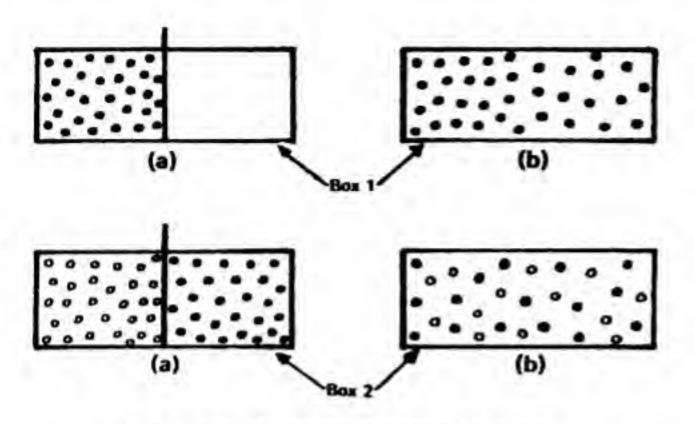


Fig. 1. Entropy increases in expansion and in miscing

(external agency). All processes whether physical or chemical that occur around us are spontaneous.

Decrease of energy

Now, what is common in all these processes which are spontaneous? It is the decrease of potential energy which occurs in all these spontaneous processes—water flowing downhill, contraction of rubber, unwinding of watch spring and falling of chalk in fact, during these processes the system tends to attain a more stable tate. The most stable state has the east amount of energy. All spontaneous processes tend to attain the nost stable state by decreasing their nergy.

Let us now try to explain the courrence of chemical reactions on his basis. Some of the spontaneous eactions accompanied by decrease a energy are given below. The ctual term used is enthalpy change astead of energy change, and is esignated as AH.

 $l_1+3H_2\rightarrow2NH_3$; $\Delta H = -24$ Kcal...(1) $H_1+O_2\rightarrow2H_2O$; $\Delta H = -136$ Kcal...(2) $A+O_2\rightarrow2O_3$; $\Delta H = -94$ Kcal ...(3) $A+CuSO_3\rightarrow2U+ZaSO_3$:

AH = - 50Kcal . . (4)

all these reactions are exothermic and the criterion of 'decrease of nergy' appears to be justified. We hay now explain the occurrence of a number of endothermic reactions, such as:

H₁+L₁+ 2H1; ΔH=+ 12.8 Kcal ..(5) C+2S++ CS₁: ΔH=+30 Kcal ..(6)

It is obvious that decrease of energy for spontaneity is not the criterion or the only criterion. There must be some additional criteria for the occurrence of chemical reactions. Let us again go back to our physical systems to look for, a suitable criterion.

Entropy

Consider two boxes (1) and (2) provided with movable partitions as shown in Fig. 1. One compartment of box (1) is evacuated and the other is filled with a gas. Such is the situation marked (a). On lifting the partition, the gas occupies the entire space of the box available-a situation shows by (b). In the other box there are two different gases, one in each of the two compartments. The two gases mix and occupy the whole space after lifting the partition. The process is spontaneous. What has happened in this process? No decrease of energy has taken place. What is the difference between the two states, (a) and (b)? In box (1) in position (b) the molecules of the gas have more room for movement, or the randomness has increased. In box (2) in position

(b), the chaos has increased and the order has decreased. Another criterion for spontaneity is the increasin randomness, chaos or disord which is called entropy. The above process is accompanied by increase of entropy (△S).

Solid ammonium chloride di solves in water. The process spontaneous, though endothermi It happens because solid particle distribute themselves throughout th solution and the randomness of entropy increases. Rubber h isoprene units as shown in Fig. 2(a and the stretched and unstretche forms are 2(b) and 2(c) respectively It is obvious from the diagram that when the stretched form contracts, goes from order to disorder or th entropy increases. The same thin happens during melting, CVE poration and the like processes. I all these spontaneous processes th entropy increases.

Entropy and chemical systems

In chemical systems the entropy change may occur as a result of rearrangement of atoms and mole cules. If the atoms, in products, an arranged in a more disordered way entropy increases in going from the reactants to products. Following examples illustrate the point:

 $NH_aCl \rightarrow NH_a(g) + HCl(g); \Delta S is +ve..(7)$ $Za + 2HCl \rightarrow ZaCl_a + H_a(g); \Delta S is +ve..(8)$



"Gold is unique, it resists acids but attracts women"

However the determination whether ntropy change would be positive r negative is not so simple s stated above. It depends upon number of factors beyond the scope f this article. In general the entropy f a system would increase if it goes rom a low temperature to a high emperature, from a small volume o a large volume, from solid state o liquid or gaseous state, from liquid tate to gaseous state, and from

indissolved strite to dissolved state.

ree escrey

It would appear from the entropy hanges of the above reactions that either ∆H and nor∆S alone can redict the course of a chemical eaction and that knowledge of both essential. If AH is -ve and Sis +ve for a reaction, it is pontaneous, and if $\triangle H$ is +ve nd ∆S is-ve it will not occur. f both are positive or negative, heir relative magnitudes will deternine the course of the reaction. he two factors have been comined in the form of an equation nd the combined term is known s free energy change (AG) which given by the equation.

therefore is the driving force behind a chemical reaction.

Fig. 2 (a) Structural unit of rabber

An example would illustrate the concept of free energy. Let us calcultie the free energies in the formetion of NO at 300 K and 2000 K

The concept of free energy explains another well known fact that there is an optimum temperature for the reaction,

 $N_1+3H_2\rightarrow 2NH_2$..(12) and that above this temperature the

been mentioned in most textbooks that this reaction is very alow at room temperature. The temperature of the reaction has to be increased to make it fast. On the other hand, the reaction does not occur at higher temperatures because AS is-ve. The optimum temperature consistent with both the facts has been found to be 500 K. The following calculation proves the point:

$$\Delta G = \triangle H - T \triangle S$$

$$= (-24) - (300) (-0.047) \text{ at } 27^{\circ}C$$

$$= -24 + 14.1$$

$$= -10 \text{ Kcal}$$
For $\triangle G$ to be zero, $T \triangle S = \triangle H$
or $T = \frac{\triangle H}{\triangle S}$

$$= \frac{-24}{-0.047}$$

$$= 500 \text{ K}$$

Since $\triangle S$ is —ve, the second term of Eq. (11) would always be +ve and it becomes larger than the first term (△H) above 500 K, i.e., △G is+ve above 500 K and hence the reaction would not occur in the direction shown. Incidently the example also shows that the back reaction, decomposition of ammonia, would occur above 500 K and not below this temperature.

Table 1 further illustrates the importance of AG in predicting the direction of a chemical reaction. ection would not occur. It has It is also obvious that a reaction

Table 1. $\triangle G = \triangle H - T \triangle S$ at 25% K

Reaction	△H Kcal/mol	T∆S Kcal/mol	∆G Kcal/mol
NO-N.+10,	-19.5 favourable	+5.4 favourable	-24.9 favourable
NaF->Na++P-	10.05 unfavourable	-0.57 unfavourable	+0.62 unfavourable
NH ++ N+ +1/4	+12 mfavourable	+7.05 favourable	+4.95 unfavourable
H,+10,+H,0(1)	-68.7 favourable	-11.7 unfavourable	-57 favourable
3H,S + N, +2NH, +35	-7.6 favourable	-23.5 malavourable	15.9 unfavourable

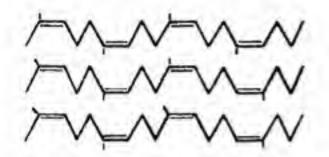


Fig. 2 (b) Stretched form of rubber

which does not occur in a particular direction under a set of conditions would take place in the opposite direction under the same conditions.

Reversible reactions

Let us now try to explain the significance of reversible reactions in the light of criterion that we have developed for the chemical reactions to occur. A reversible reaction is one which can proceed in both the directions under similar conditions. This appears to contradict or atleast create confusion about what has been mentioned so far. However, this is not true and a slightly different approach would enable us to understand the occurrence of reversible reactions.

Equilibrium and free energy change. All reversible reactions are associated with an equilibrium constant defined by the ratio of the products of the products of the products of the products of the reactant-concentrations, each concentration term being raised to a suitable power which is the coefficient of the formula in the stoichiometric equation. Standard free energy change and equilibrium constant are related by the following equation,

$$\triangle G^{\circ} = -2.303 \text{ RT log K}$$

where K is the equilibrium constant.

A system may be in equilibrium or may not be in equilibrium. All systems which are not in equilibrium tend to attain the equilibrium with the decreases in free energy. The free energy change for a system at equilibrium is zero. In other words, a particular process occurs because the system is not in equilibrium and it tends to attain it. A chemical

system in equilibrium means a reversible reaction which has attained the state of equilibrium. It is well known that a chemical equilibrium can be approached from both the directions. If the system is not in equilibrium, it would attain it by moving in one of the two directions.

At 25°C, the equilibrium expression for the reaction.

$$CO(g)+H_sO(g)\rightarrow CO_s(g)+H_s(g)$$
.....(13)

is given by $\frac{[CO_g(g)]}{[CO(g)]} \frac{[H_g(g)]}{[H_gO(g)]} = 1.02 \times 10^6 ...(14)$

Suppose we take three different gas mixtures as shown in Table 2.

Table 2

Mixture	Initial co	oncentra	tion (mo	les/litre)
	co,	н,	co	H,O
1	0.16	0.15	0.05	0.20
2	1.0	2.0	0.001	0.002
3	0.51	2.0	0.002	0.005

Although the equilibrium constant is large, it is not possible to predict the course of the reaction for any of these three mixtures. For mixture 1, the initial concentration quotient is,

$$\frac{[CO_{g}(g)] [H_{g}(g)]}{(CO(g)] [H_{g}O(g)]} = \frac{0.16 \times 0.15}{0.05 \times 0.20} = 2.4$$

Hence Kegut > Kinitial

In order that equilibrium is attained the concentration of CO₂ and H₃ must increase and that of CO and H₃O must decrease. This means CO and H₂O must react to yield CO₂ and H₃ and hence the reaction must occur from left to right.

For mixture 2, the initial value of the concentration quotient is,

$$\frac{[CO_{g}(g)][H_{g}(g)]}{[CO(g)][H_{g}O(g)]} = \frac{1.0 \times 2.0}{.001 \times 0.002}$$
=1 × 10⁴

and, therefore, Kanal < Kinimit

In this case equilibrium would be attained if the concentrations of CO₃ and H₂ decrease and that of CO and H₂O increase. Obviously, the reaction would occur from right to left.

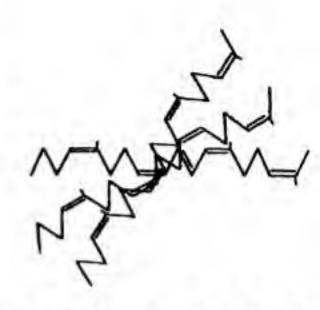


Fig. 2 (c) Unstretched form of rubber

For mixture 3, the initial value of K is,

$$\frac{[CO_{g}(g)] [H_{g}(g)]}{[CO(g)] [H_{g}O(g)]} = \frac{0.51 \times 2.0}{0.002 \times 0.005}$$
$$= 1.02 \times 10^{4}$$

and so Kequi = Kinital, i.e., the initial concentrations correspond to equilibrium concentrations and reaction would not occur.

We say that there is free energy decrease (△G = -6.8162 Kcal/mole at 25°C for the change

$$CO(g)+H_{\bullet}O(g)\rightarrow CO_{\bullet}(g)+H_{\bullet}(g)$$
....(15

and therefore the reaction should occur in the direction shown. So far it is alright, but what is the explanation in the light of this argument for mixture 2 where the reac-



"It takes two, dear Anita, to produce a reaction."

on occurs in the opposite direction. he reason is that the above free nergy decrease of —6.8162 Kcal/sole refers to standard state of the stem whereas the mixtures 1 and 2 re not in the standard state. In sch cases the free energy decrease given as below:

$$G = -RT \ln \frac{K_{\text{equi}}}{K_{\text{initial}}} \qquad ..(16)$$

n case of mixture 2, $\triangle G$ is positive and reaction (15) does not occur in the direction shown. Instead, the eaction occurs in the reverse direction. The result is the same as stational above. In case of mixture 3, eq. (16) gives a value of zero for $\triangle G$ and hence no reaction would occur either direction.

If simply a mixture of CO, and I, is taken and no CO and H,O, amounts to a situation when neggible amounts of CO and H,O re present, and the concentration uotient [CO,] [H,]/[CO] [H,O] will e very large and \(\triangle G \) will be positive. Therefore, the reaction (15) is written, will not occur but the everse reaction will take place, i.e., CO, and H, will react. We see that reversible reaction can occur both ways and still the principle of free nergy decrease is obeyed.

The question now arises is: What the significance of terms 'reaction occur' and 'receation does not occur' and, 'favourable' and 'unfavourable'? What term should we realy use; as eactions can occur both ways, 'occur' and 'does not occur' are therefore misseading terms. We should use terms, favourable' and 'unfavourable'. Re-

action (13) is said to be favourable in the right direction. However, if we start with CO, and H, at 25°C, some reaction does take place, i.e., small quantities of CO and H₂O will definitely be formed. However, the change is so small that the reaction is considered to be unfavourable in the left direction at 25°C. 'Favourable' and 'unfavourable' terms are therefore relative and depend on the equilibrium constant. At 25°C the forward recation (13) occurs to a large extent and hence is favourable. The reverse reaction occurs to a small extent and is considered unfavourable. Larger the value of equilibrium constant than one, the more favourable is the reaction. In other words, the more negative the value of AG the more favourable is the reaction.

All reactions are reversible

At this stage it would be appropriate to introduce one more concept useful to our understanding of the occurrence of chemical reactions. All reactions are considered to be reversible and even the following typical reaction (17) is reversible: BaCla+HaSO BaSO +2HCI..(17) It has a very large equilibrium constant. If we start with equimolar mixture of BaCl, and H,SO, the concentrations of these at equilibrium would be very small. Even such reactions are truly reversible, is proved by the fact that if BaSO, and HCl are mixed, small but detectable concentrations of Bast and SO, to are found in the solution. Similarly, a reaction like the decomposition of

KC10, at 400°C is reversible provided ed it is carried out in a closed vessel so that the product (oxygen) does not escape.

2KC10,-42 KCI+30,

Conclusion

We can now summarize the conclusions as follows (1) all reactions are reversible; (2) reactions occur because they are not in the state of equilibrium and they tend to attain it; (3) the equilibrium can be attained from both directions, i.e., a reversible reaction can occur both ways; (4) the extent of reaction to reach equilibrium decides the 'favou rableness' and 'unfavourableness' (5) in terms of equilibrium constant the larger it is then one, the mon favourable is the reaction; (6) in terms of free energy decrease, the more negative it is, the more favou rable is the reaction; (7) in terms o enthalpy change, the more negative it is for a reaction, the more favou rable it is; and (8) in terms of entro py change, the more positive it i for a reaction, the more 'favourable it 15.

Further reading

- (1) Fischer, R.B., and Peters, D.G. Chemical Equilibrium, W.E. Saunders Company, p. 20, 1970
- (2) Ashmore, P.G., Principles of Chemical Equili brium, Mono graph No. 5, Royal Institute of Chemistry, p. 17, 1967.
- (3) Dasent, W.E., Inorganic Energe tics, Penguin Books Ltd., p. 32 1970.
- (4) Selly, N.J., Chemical Energetics Edward Arnold, p. 92, 1971.



H.L. BAMI

Science is now increasingly aiding detection of crimes

CIENCE plays a direct or indirect role in all human activities oday. One of the effective ways n which science can be concerned ith the well-being of the society in its application for the mainenance of law and order in the ociety as expressed in the constant igil against crime. In this task, very branch of basic sciences nd their methodology are being mployed to assist in the administraon of justice with special reference crime investigation. This entire oplied field of scientific activity is roadly termed as 'Forensic science'. hus the forensic scientists of today, y virtue of their specialisation, work ith the law and order agencies to ffer expert scientific data on tangible hysical objects associated with rime. This, in turn, helps to ob-

jectively prove the innocence or guilt of a person in any crime. Although this specialised branch of applied science, in some form or the other, is more than a century old, significant progress has been achieved only during the last 40 years or so. This coincides with the period when science and technology made great impact on the human affairs in the world. Universal acceptance of forensic science as a basic arm of law and order set-up, and its extensive use in all the advanced countries has made a significant impact on the society's determined effort to meet the challenge of alarming increase in sophisticated crimes and violence. In fact today, it has become imperative that law and order agencies should be basically assisted by modern scientific

aids as offered by forensic science in protecting the innocent and pu nishing the guilty. The conventions reliance on the eye witness an the verbal testimony as a proof of guilt or innocence are neither prac ticable nor reliable today. In fac society with its present congestion mobility and complexity demand recourse to more objective scientifi methods as a part of the crimin justice system than hitherto available Forensic science has given a ne shape to the methods of crimin revolutionalised a justice and important aspect of human soci activity.

Development of foreasic science

Nearly a century ago some is lated attempts were made to u the available scientific and medic

Dr. Bami is Director of Central Forensic Science Laboratory, C.B.I., New Delhi.



Operation of gas liquid chromatograph for analysis of micro-quantities of inflammable liquids, drugs, narcotics and alcohol

nowledge in the investigation of ime by police forces in some counies. However, this work was ostly limited to simple chemical nalyses and medico-legal examinaons. The first organised breakgrough came in 1879 when Alphonse ertillon in France introduced Anthropometry", a scientific menod for personal identification based n body measurements, etc. This stem was universally replaced by a nore scientific and foolproof fingerrint system in the early years of the resent century. Meanwhile, Euroean countries took a lead in the pplication of science to criminal nvestigation and some of the pioeers in the field were Professor acassagne, Professor Hans Gress, R.A. Reiss and Edmond Locard. ocard established the first forensic cience laboratory in 1910 at yon in France. This was followed by other such laboratories in eighbouring European countries luring the twenties. F.B.I. laboatory in U.S.A. was started in 1932

followed by a laboratory for the Scotland Yard in London in 1935. All these institutions were generally small and the subject gradually gained recognition over the years. However, the major fillip in the field of forensic science came after the end of World War II when extensive expansion of forensic science institutions was accomplished all the advanced countries meet the mounting challenge of crime involving sophisticated firearms. At present, nearly 200 forensic science laboratories aid the law and order agencies in USA (and even they are considered insufficient) whereas even a small country like the U.K. maintains 13 such laboratories which assist the police and the courts. The position in other modern countries including Japan is satisfactory and if there is a deficiency, it is constantly being made good. These developments have naturally also triggered establishment of similar institutions in developing countries

though at a slower pace and with less sophistication. Today the subject has wide acceptance and considerable investment in terms of men and equipment is being made in this field by many countries.

How does forensic science work?

For the investigation of crime and its punishment by legal justice, increasing reliance today is being placed on the methods of science and technology. In practice, wheneve a criminal act takes place, there i always contact with tangible physi cal objects of diverse nature which involves transfer of trace material between the object and the perso concerned. A forensic scientist i concerned with determination of th identity and degree of individualit of these tangible physical object associated with crime. Such analysi and comparison may have to be per formed on a finger print, a foo print, sample of earth, cloth, chi of paint, metal or glass, etc. I criminal cases involving injury to th iuman beings, such examination and omparison would cover bones, fibres, air, blood, semen, saliva, tissues, tc. Tool and tyre marks, explosive esidues, bullets, cartridges, traces of oisons and narcotics are some of he other physical exhibits which are ften selected for analysis and comarison. Such scientific data help stablish a link in the chain of events ssociated with a crime. For insance, if a finger-print found on a siece of glass is compared with that f the culprit, it is a proof of the act that he had come in contact with he glass during commission of the rime. Similarly, a bullet recoveed from the body of the victim an he accurately compared with imilar bullet fired from the weapon ecovered from the possession of the nurderer. The scientifically estadished connection of the spent bulet to the weapon with the criminal s a significant link which may olve a crime. Semen group deternination and comparison as applied o a male suspect and the victim of ape, can similarly support the fact f the crime. Even negative matchng in these cases helps eliminate ertain innocent suspects. These bjective scientific assessments proide factual data which correctly econstruct the events associated with crime. However, it may be poined out that forensic scientist in his rofessional status is neither a witess for the prosecution nor of the efence but a witness of the court. le provides independent scientific ata on which the court may place eliance in final dispensation of jusice. Some of the broad fields of pplication of forensic science are riefly discussed below.

hysico-chemical methods

Physico-chemical analysis and comarison of materials such as pieces f paint, metal fragments, soil, fibres, lass, plastic, etc., utilise basic techiques like emission spectrography, mass-spectrometry, atomic absorp-

tion spectroscopy, x-ray diffraction, x-ray fluorescence, infrared and ultraviolet spectrophotometry. The composition (specially in respect of trace elements present) of these exhibits is determined and compared inter se and with standards, as required. The new techniques such as neutron activation analysis have also been used to compare qualitatively and quantitatively data on trace elements in respect of objects associated with the scene of crime and the suspect. For instance, profile of trace elements in a flake of paint or glass at the scene of crime when found identical with that of the car paint or glass does prove that the said car was most probably involved in the case. Microscopic examination of minute physical evidences such as powder residues, paint flakes, fibres, hair, etc., has also progressed to include the use of scanning electron microscope (SEM). This comparative technique gives stereoscopic magnification several hundred times more than those offered by conventional microscopes. Comparison of micro-surfaces by SEM also gives valuable proof of common identity. Use of gas-liquid chromatography (GLC) is of particular importance as this technique has been extensively used for microestimation of organic substances such as drugs, narcotics, explosives, paints, fibres, inflammable products, etc. Use of GLC with mass-spectrometer has made it possible to identify and estimate even a minute quantity of a drug and its metabolites as present in blood, urine or any other materials. These methods have also been employed for routine estimation of alcohol in blood or breath in cases of drunken criving. Similarly, automated methods for analysis of alocho' narcotics, drugs, etc., in urine or blood have been developed whier enable routine screening of hundreds of such samples daily. The largest portion of forensic science work is covered under

534

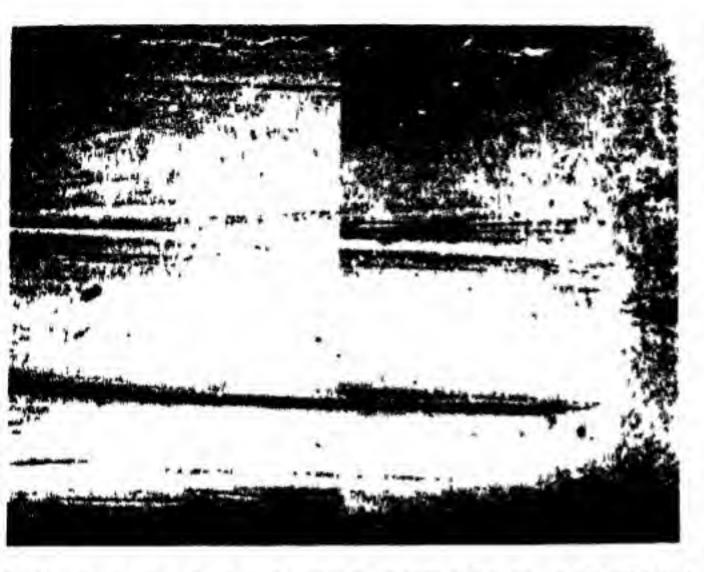


"The first thing we have to learn to follow in the footprints of the criminals"

this group and its horizon is ever expanding. There is increased en phasis on instrumental analysis an automation though ordinary laboratories still use conventional techniques of physical and chemica analysis.

Biological examinations

In crimes involving body injury murder, rape, etc., it is imperative that the biological material associa ted with person(s) should be exam ned and compared to provide ev dence linking the crime with the cr minal. Forensic biologists not on determine whether a given stain of human blood but also compare i blood group with that of the star dard or known blood stain. Apa from the conventional ABO bloo grouping, specialised blood group ings like MN, Rh, etc., are also use in this work. Furthermore, huma blood contains a number of specif enzymes in various polymorph forms. Determination and con parison of blood enzymes such a PGM, AK, hepato-globulin, ADA etc.. have received considerable atter tion. In fact, today it is possible t match the blood of the victim wit the blood stains found on the clo thes of the accused with great ter degree of certainty by resorting to sophisticated serological and bid chemical techniques (involving elec trophoresis). Similarly, detection



Matching the strictions found on the crime bullet (left) with those on the bullet fired experimentally (right) using the comparison microscope

nd comparison of saliva and emen including their groupings are tandard techniques. Examination nd comparison of body hair ot only by means of morphological haracteristics but also by neutron ctivation analysis (where micro netallic constituents like zinc, merury, copper, arsenic, antimony, mananese, etc., are compared) has ielded very useful results. Simiarly, examination of tissues, teeth nd botanical drug materials incluing wood, fibres, etc., have offered aluable scientific evidence to idenify and/or connect the victim or the uspect to a given incidence of rime. In fact "forensic odontoogy", a science dealing with identiication and study of human teeth, as already made rapid strides as a eparate discipline by itself. By tudy of skeletal remains releant questions like height, age, staure, sex, etc., of the person can also e answered. If a photograph of he deceased is available, the recovered skull is matched by the photo super-imposition technique to estaolish common identity. The modern echniques like radio-immuno-assay

are also being increasingly used for detection and estimation of drugs and narcotics.

Examination of firearms and explosives (forensic ballistics)

In crimes of murder, violence, sabotage, rioting, etc., examination of fire-arms (including explosives) is a major function of the forensic ballistics experts. In order to determine whether a given crime bullet has been fired from a particular gun, a precision comparison microscope matches the striations on the crime bullet with those produced experimentally by firing a similar bullet from the suspect weapon. The photographic data provided is a fool-proof evidence on which great reliance is placed in the court. Reconstruction of scene of crime involving firearms can help to pin point the manner in which a firearm has been used in a crime, revealing the truth. So far as detection of explosives is concerned, apart from conventional methods of analysis, highly sensitive gas-liquid-chromatographic methods have been devel-o ped to detect even micro-quantities

of volatile explosives (TNT, RDX CE, etc.) using air-monitoring de vices. This equipment is being rou tinely used at airports and other areas where danger of explosive mi suse exists. Letter bombs, recently a menace to the public, are also studied by x-ray photography whil crude country made bombs an grenades are identified even from their exploded fragments. In fact search and analysis of debris found at the scene of explosion is th latest approach by which the nature o explosives and explosive device used can be accurately determined. Detec tion of micro-quantities of explosive residues (in terms of antimony lead, copper, bismuth, etc.) on the hands and/or clothes of the person by chemical analysis or by neutron activation analysis is another im portant tool which helps to provid important link when a suspect i involved in shooting.

Detection of document frauda and forgeries

In modern society crime is no limited to that of violence only The white collar crime today i whic a more serious menace being effectively counteracte with the help of forensic scientist expertise in documen having examination and science of finger prints. Cheating, frauds, embezzle ments, etc., often involve alterations additions, erasures in the existin documents or by forging the entir document with an intention t cheat. This activity may cove cheques, drafts, money orders, lotter tickets, government orders, receipt certificates, export licences, univer sity degrees and a host of other documents from which a gain ca be made by an unscrupulous per son. Examination of such question ned documents is a highly spe cialised field in which not only the stereoscopic microscopy play an important role but infrared an ultraviolet photography also hel considerably in detecting erasures and overwritings. For instance, inks ere opaque to infrared rays to varyng degree depending upon their nature and composition. A comvarison with infrared image-converter clearly reveals the alterations, overwritings, etc., attempted by the ulprit. Use of thin-layer chromaography and allied techniques also selp in comparison of inks while paper is analysed for its fibres and nineral used for sizing, etc. Forperies of handwriting are unearthed on definite scientific basis and even ttempts to disguise the handwritngs can be revealed. In fact, various spects of questioned document exanination effectively help the police o fight the menace of white collar rime.

Other scientific aids in crime investication

Apart from scientific methods and echniques discussed above, forensic cience also helps the police investiator in several other scientific fields which are equally important. Polyraph (Lie-detector) is a highly ophisticated instrument which, on he basis of psycho-physiological nalysis, is able to detect if a suspect s concealing certain facts associaed with a crime. Revelation of this uilty knowledge has proved to be of reat help to the police in their fort to solve a crime. It has been ften possible to obtain confessions in the basis of data provided by he lie-detector. Central Forensic cience Laboratory, New Delhi, or the past three years, has been outinely using the lie-detector to ssist the metropolitan police in Delhi o criminal cases. Similarly, use of oice-spectrograph for comparison of uman speeches has been utilised in ases involving demands for ransom, neats, black-mail, etc., especially the USA. In these cases, by using he standard technique of voice pectrography, it is possible to pick p a suspect by graphic comparison

of the recording of his normal voice and the recording of the incriminating conversation. Use of photography in correctly recording the scene of crime and identity of the objects and individuals has greatly expanded over years. Modern sophisticated cameras. movie cameras and video-tape recording systems are being routinely used by police forces all over the world. A scene of accident is sometimes photographed even from a helicopter, if this would help to clarify the case. Movie pictures of rioting and other disturbances give valuable authentic information regarding the incidence. In fact even colour photography is being increasingly used for purposes of comparison and correct identity.

Use of scientific comparison methods for tyre, shoe and tool marks, etc., has given valuable aid in cases of accidents, burglaries and thefts. These methods are standard tools in the hands of forensic scientists to reveal the truth. This is apart from science of fingerprint comparison whose utility is beyond doubt.

Some important criminal cases

(a) An eccentric rich youngman was found dead in his bed holding a pistol in one hand, while some cartridges were also found lying on the side table. There was a suspicion of suicide but a strong motive for murder could not be ruled out. The police was baffled due to lack of suspects. However, solution to the mystery was sought through scientific examination of the physical clues. The bullet wound on the temple by its nature was confirmed as a contact wound (very close range firing) by the forensic ballistics expert. For this purpose, a series of experiments using another human skull were conducted in order to duplicate the actual skull fracture. The '22 pistol on thorough examination was found to be defective with respect to the trigger mechanism. Careful examina-



"As the criminal has left no fuclues behind, the Forensic Laborator has advised us to depend on commusense and traditional methods to trathe criminal"

tion of the cartridges available of side table in the room revealed that some of the cartridges had firing pi marks but they did not fire due t defective trigger action. Recontruction of the scene of crime, coup led with laboratory data made it clea that the deceased could not have bee shot by another person from contac range when several cartridges had t be tried before one got fired to kil The only other possibility was that h committed suicide by repeatedly firing the defective weapon till one of the bullets pierced his head The scientific examination with res pect to physical evidence was carried out months after the incidence and it offered a good proof that there was very little scope for foul play.

(b) A British nurse who landed at Delhi airport hired a taxi. The taxi driver, however, took her to a lonely place where she was raped robbed and then murdered. She was carried in the luggage boot of the taxi to another location where ar unsuccessful attempt was made to burn the body. The police on inquiry were able to interrogate the suspect but he denied the charge However, the last was brought for thorough examination to the Central Forensic Science Laboratory, New Delhi. On very careful examination, blood stained earth and some fibres were collected from the lug-



A modern polygraph (Lie-detector) in operation on a suspect at C.F.S.L., New Delhi

gage boot. On careful microscopic examination, woolen and other mannade fibres of several different coours were found which matched with similar fibres from half burnt op coat of the nurse. Similarly, races of blood of human origin could also be detected in earth weepings collected. This indicated hat the dead body had been dumbed in the luggage boot and then tragged out of it. These scientific indings fitted into other facts of the ase and the culprit ultimately dmitted the guilt.

(c) Use of gas-liquid chromatoraphy in micro-detection of petroeum products and other inflamnable liquids helped to solve a tricky ase. A burglar set-up a small fire his hut, using kerosene, in order scare the raiding police party which had come to arrest him at nid-night. However, the fire flared p and his pregnant wife received erious burn injuries and later died the hospital. The criminal tried shift the blame to the police and ocused them of setting fire to his ut by throwing petrol on it from utside. Considering the sensatioal nature of the case, the police

officers immediately called the forensic science experts to examine the area and other articles allegedly used for arson. Burnt residues of cloth which was used to start the fire and the sample of earth floor underneath, when examined by GLC, established the presence of kerosene which was also qualitatively identical to the bottle of kerosene available in the hut. The statement of the culprit that the police had set fire to his house by using petrol was also not substantiated as no trace of petrol residues was found in any of the exhibits collected from both inside and outside of the hut. The police action was cleared.

(d) The wife and a little daughter of a senior government officer were robbed and murdered by two young servants of the house in multi-storey flats at R.K. Puram, New Delhi. No clues with respect to fingerprint, footprint, blood stains, etc., could prove helpful in apprehending the criminals as all persons involved lived together. The servants completely denied having committed the crime and also no proof to the effect could be obtained by the police even after exhaustive search and

interrogation. The suspects were asked to take a lie-detector test and their response clearly showed that they possessed guilty knowledge regarding the murder of these two innocent women. There was also indication that they were hiding the truth in other related matters. Confronted with this data, the suspects broke down, confessed their guilt and the stolen ornaments and money were recovered from their hiding place as a proof of their having committed the crime.

(e) A social worker received a normal certificate of commendation for his work from a Minister. He kept the signature of the Minister intact but chemically erased rest of the text. He then addressed a letter on the same letter paper to the head of a public limited company asking them to give him a job. This letter was apprehended and a careful examination of the documents revealed that the original text had been chemically erased. To conduct this test, ultraviolet photography was used. Secondly, the handwriting of the suspect was also matched with the forged writing by which he wanted to secure a job.

status of forensic science in India

Under the British system of justice, Government Chemical Examiner's aboratory was established at Calutta, as early as 1853, followed by imilar laboratories in Madras, Sombay, Lahore and Agra These mall laboratories were essentially neant for simple chemical and toxiological analysis of viscera as a elp in the medico-legal cases. This ystem was later supported by the erologist and Chemical Examiner to he Government of India, Calcutta, stablished in 1910. An office of he Government Examiner of Quesoned Documents also was stablished in Simla in 1906. inger Print Bureaus were estabshed in all the States by about 910. These facilities were, however, udimentary and had a very limited npact on crime investigation.

Considering the growing importnce of forensic science all over the orld, in post-independence India the rst State Forensic Science Laboraory was established at Calcutta in 952 by expanding the then existing overnment Chemical Examiner's aboratory. Government of India so established a Central Forensic cience Laboratory at Calcutta in 957. States were also simultaneously couraged to set-up their own State rensic science laboratories. As a sult of all these efforts, the flowing forensic science instituons are today available in the ountry:--

States having forensic science laboratories: Bengal, Maharashtra, Tamil Nadu, Karnataka, Andhra Pradesh. Gujarat. Uttar Pradesh, Bihir. Madhya Pradesh. Kerala, Orissa, Rajasthan, Assam, Jammu & Kashmir, Haryana and Union Territory of Chandigarh.

Central forensic science institutions: Central Forensic Science Laboratories at Calcutta, Hyderabad and New Delhi. Govt. Examiners' of Questioned Documents Laboratories at Simla, Calcutta and Hyderabad Serologist and Chemical Examiner to Govt. of India, Calcutta.

above institutions are under active expansion in order to make their services available to crime investigators. Regional and branch laboratories of these main institutions are also available or are being proposed Apart from these, The Institute of Criminology and Forensic Science, New Delhi, established in 1970, undertakes inservice training in various specialised fields of forensic science. Universities at Delhi, Madras, Karnataka, Patiala and Sagar also conduct postgraduate diploma and degree courses in forensic science. The Indian Academy of Forensic Sciences, established in 1961, represents the profession in the country. However, the present progress though significant still falls short of the total needs of a country so large as ours. We may need in the near future around 200 such laboratories if we have to provide adequate help

to police in scientific crime investig tion. Government of India has give a special loan-cum-grant assistant to the States for modernisation of their police forces and nearly Rs. crores of this aid has gone int equipping the State Forensic Science Laboratories with the latest scientifi equipment during the last six year However, considering the basic role of forensic science in criminal justice, th present efforts and investments nee several fold increase. This is on aspect of this applied science which has given rich dividends everywere We cannot afford to neglect its deve lopment if we wish to achieve a hig standard of criminal justice.

Further reading

- Kind, Stuart and Overman Michale, Science Against Crime Piers Stanley, 14 Southville Terrace, Ripon Road, Harrogate Yorkshire, England (1972).
- Walls, H.J., Forensic Science Sweet & Maxwell Ltd., 11 New Fetter Lane, London (1968)
- Kirk, Paul L., Crime Investigation—Physical Evidence and the Police Laboratory, Interscience Publishers, Inc., New York, (1966)
- O'Hara, Charles E. and Osterburg, James W., An Introduction to Criminalistics, Fitzhenry & Whiteside Limited, Don Mills, Ontario (Canada) (1972).

ago, the reptiles began to invade the three media—land, water and he air. This was possible because their ecological advantage over heir closest competitors, the amphisians. The reptiles were no more sed to water to lay their eggs, because hey had developed a shell around he egg and also during development he embryo became surrounded by series of membranes called emryonic membranes which afforded notection, even from dessication.

During this age of reptilian radia-

the phytosaurs and the crocodilians who share many common features. They exhibit a convergent evolution towards excellence in secondary aquatic life. While the crocodilians still have three surviving families, the dinosaurs and the phytosaurs have become extinct. Today the crocodilians form one of the four surviving reptilian groups (Orders: Chelonia—Turtle and tortoises, Rhynchocephalia—the tuatara, Squamata—snakes and lizards and the Crocodilia).

The earliest known crocodilian

group including forms like phytosaurs. During the course of it evolution it gave off many side branches, which are now extinct. The forms existing now differentiately in their morphology anatomy and physiology from their earliest representatives.

Living crocodilians

The Crocodilian order constitute three living families—Alligatoridae Crocodilidae and Gavialidae. The Alligatoridae includes alligator



Until recently, crocodiles were found in large numbers in India and elsewhere. They are depleting fast due to indiscriminate hunting

LALA A.K. SINGH

ion (Mesozoic era), there appeared he most gigantic forms of the animal istory—the dinosaurs, the 'terrible zard', though in no way they had ny direct phylogenetic relationship, e., any direct evolutionary follow up, with the lizards. Contemporary to the inosaurs were two groups of reptiles which had sway over the aquatic nvironment. These reptiles were

is Proterochampsa barrionuevoi. This was discovered in Western Argentina in fossil beds dating to the middle Triassic (about two hundred million years ago). Other early crocodilians were Sphenosuchus from South Africa and Protosuchus from Arizona, etc. Of them the best known is Protosuchus. Two hundred million years ago the most primitive crocodilian

and caimans. The characterist feature of the family is the broad short snout and the ponthe upper jaw providing space that the fourth tooth of the lower jaw Alligators are found in the Souther United States (A. mississipiensis) and China (A. sinensis). The caiman which differ from alligators in having overlapping ventral scutes, are found

in Single is to carely scholar at Gharait Research and Conservation Unit, Tikerpada-759122 (Orissa)



Fig. 1. Tail of crocodilian—a powerful muscular organ used in swimming. Its proximal double and distal single-crested make-up forms the distinguishing feature for crocodilians. The tail is still a legendary organ for many people

tates. The American alligator grows four metres in length. The black aiman (Melanosuchus niger) grows in five metres and is the longest aiman. The broad nosed caiman Caiman lutirostris) of Eastern Brazil ivers grows only to two metres in ength.

The Crocodilidae includes the rue crocodiles (Crocodylus sp.), the warf crocodile (Osteolaimus sp.) nd the false gharial (Tomistoma chlegeli.) They are found ver the world excepting Europe here the climate is too cold for hem. There are fourteen species f crocodiles. The false gharial is fish-eating crocodile with a long nout having four rows of teeth, two n each jaw. They occur in Malaasia, so are often called Malayan harial. Because it has a superficial esemblance to the Indian gharial in aving a long snout, it is called false harial. The false gharial grows a length of five metres. It is said actively pursue its prey in contrast the Indian gharial. The mandiular symphysis (the line of junction etween right and left halves of the ower jaw) is very long, extending ack to the level of fourteenth or fteenth teeth. In the gharial it oes not extend beyond the eighth oth.

The Indian gharial Gavialis gangetias is the sole surviving member of
s family Gavialidae. Its natural
abitat is the Himalayan-fed rivers.
is a natural species occurring in
lepal and in the North Indian rivers.
liver Mahanadi of Orissa is the only

river outside this region to have gharial and it once harboured one of the best gharial populations.

Indian crocodiles

In India, there are two types of true crocodiles and gharial. Orissa is the only state today to have all these three species. Of the two true corcodiles, one is estuarine (estuarine or salt water crocodile) and the other is fresh water (Mugger or marsh crocodile).

The estuarine crocodile (Crocodylus porosus Schnieder) is widely distributed. In India, only two populations have been left, one is the Bhitarkanika Island and the adjacent mangrove areas of Orissa and the other is the Sunderbans of West Bengal. It grows to a length of seven metres.

The Mugger (Crocodylus palustris Lesson) is widely distributed in India. It grows to a length of five metres. In contrast to porosus, they have four prominent post-occipital scutes.

The genus Gavialis for the Indian gharial Gavialis gangeticus (Gmelin) is the Latinized version of a misspelt Gharial. The name takes its origin from the presence of an inverted pitcher-like structure round the nostril at the tip of the long snout in males. In most of the north and east Indian states, a pitcher is called

a ghara or ghari. The ghari believed to develop after the ma attains a length of about 2.5 metre During breeding season the ma gharial is very noisy. The sour produced is a combined effect of vocal and nasal sounds. Probab the ghari serves as a resonating orga for the nasal sound waves. Gharia reaches a length of eight metres. I India, the Satkoshia Gorge of Rive Mahanadi (Orissa) is one of the be gharial habitats. The Satkoshi Gorge with its number of deep pool of flowing water, good sand bank for basking and nesting and a goo fish population is an ideal gharia habitat.

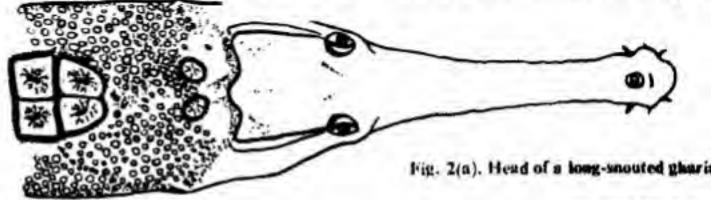
The gharials are harmless to huma beings. People living around the Satkoshia Gorge have a balance relationship with the gharial, neither interfering in the other's activities.

Characters

Crocodilians are amphibious—the live in water but come out to bash As an aid to their aquatic life, crocodilian eyes are equipped with a thirty eye lid, the nictitating membran which moves across the eye to protect them during submergence without interfering vision. The hindlimbs are webbed. Crocodilians like mammals have a four-chambere heart, found in no other reptile.

Crocodilians lay their eggs either under the sand or in a speciall prepared nest of sticks and deadleaves. In general, those nesting during the dry season nest in sandbanks (gharial and mugger), whereas monsoon nesters build the nest as a mound on the ground, because the banks are flooded during that time of the year (porosus).

Crocodilians reach maturity a



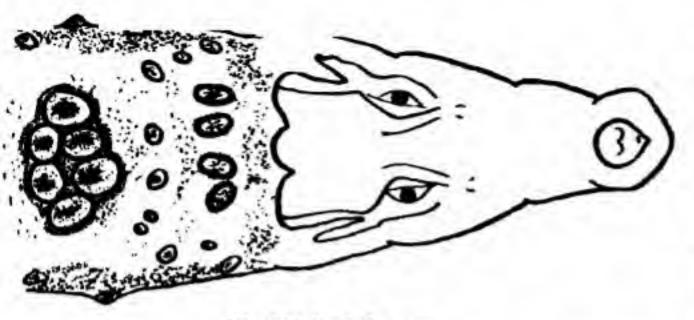


Fig. 2(h). Head of manger

age of six to ten years. Usually iere is no obvious external sexual morphism. When they are about 5 cm long, the genital organ can be It in males by probing into the ent. It is interesting to note that e gharial is the only crocodilian to ave a marked distinction between the xes - the presence of the ghari in e male. A newly matured female ould start laying eggs at the rate f about 20 per annum. Only one utch of eggs is laid once a year. As ne female grows older and larger, or egg laying capacity increases, in ome species it is hundred eggs. The verage size of an egg is 5 cm to cm long. The incubation period two to two and a half months. hen born, the hatchlings are about 0 cm in length. There is a high ortality percentage during the first w months of life. Growth rate epends on temperature and food apply. The life span of crocodilians nay be over a century. Once they ecome large, over a metre in length, ney have no successful enemies acept man and other crocodilians.

he present position in India

Until late nineteen hundred and flies crocodiles were in large numers. After that the entire crocodian order has faced critical depletion oth in India and outside. Survival a some species like the Cuban rocoville (Crocodylus rhombifer), andian gharial and the false gharial, itc., is in jeopardy.

The main cause for the depletion

valuable hide of the crocodilians. Hunting for their skin has also been the main cause for the destruction of Indian crocodilian populations. Gharial populations in India have been greatly affected due to habitat alienation through construction of dams and concrete embankments destroying nesting grounds.

Introduction of new fishing methods by using nylon gill nets is another serious reason for the loss of crocodilian populations in India. These nylon nets, which are set in the evening and taken out the next morning, prove fatal to the crocodiles and the gharials as they quickly drown due to struggling. If they escape drowning in the water, they are clubbed to death to save the net. Also, deliberate killing of mugger crocodiles in India with the mixconception that it would promote fishery has greatly reduced their number. On the contrary, crocodiles help to increase fish population.

Indian concern

Becoming increasingly concerned about the dwindling crocodilian population in the country, the Government of India banned their killing and export in 1958. The formulation of the Wildlife Protection Act (1972), now adopted by most Indian states has strengthened their security. It is illegal to possess any live captive Indian cree dilian or any part thereof in any form, without authority from the Chief Wildlife Warden of the State. Penalty (firs offence) is mandatory imprisonmen for not less than six months together with a fine which shall not be less that Rs 500.00. Further, an offence relat ing to hunting in a sanctuary or a national park shall attract minimum penalties of double the above.

During a three month mission to India, May to July 1974. Dr H.R. Bustard of FAO investigated the status of all three Indian crocodilians and in his report refered to it. He reported that the gharials are on the verge of extinction and could only be saved by active management techniques operated in association with specially created sanctuaries.



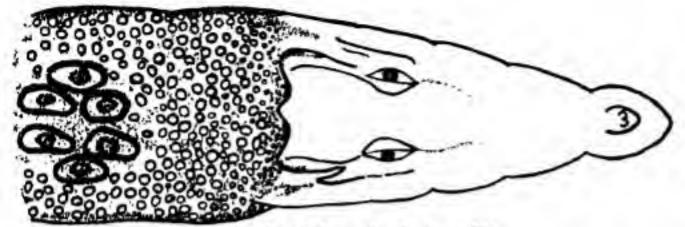
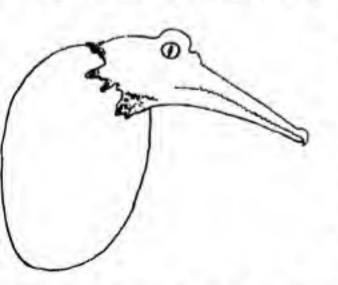


Fig. 2(c) Head of an estuarine crocodile

where poaching could be controlled. Since gharials occur only in India ind Nepal, Government of India howed immediate concern. He eferred to the mugger as a depleting pecies, not yet endangered and still present in most states, but disappearng faster than it can reproduce itelf. He recommended the developnent of pilot projects in West Bengal ind/or Orissa. In April 1974 the Drissa Government (Forest Departnent) had decided to protect the charials by appointing two local illagers of the Satkoshia Gorge as guards. Following the experts' recommendation, an integrated scheme on crocodilians and sea turtles was tarted in Orissa in April 1975 and low the number of gharial guards as increased to ten.

Work in Orissa

Being master predators, large



Mummy! is it safe to come out of the

from man. At the egg stage crocodilians have many enemies such as monitor lizards, jackals and even tribals who relish it as a food (the tribals are most organised and effective). All eggs in a nest are not fertile. Only a part of the fertile eggs can be expected to hatch. The young hatchlings too have many enemies—fish, birds, nets, more particularly the nylon set nets. During the first year of development a large number of hatchlings are lost. Sometimes the survival percentage is nil.

For the gharials the Orissa Government has a gharial rearing project at Tikerpada, a village four and half km downstream the beginning of the Satkoshia Gorge of the River Mahanadi. An area of about 950 sq km, having the Satkoshia Gorge as the sanctom sanctorum, has been declared a sanctuary for the gharials. The estuarine crocodiles are similarly reared at Dangmal in the Bhitarkanika mangrove surrounding. This area has also been declared a sanctuary. The station for the mugger is ready to be started at Similipal Tiger Reserve of Mayurbhani district. Another sub-scheme at the State Biological Park at Nandankanan intends to captive breed and battery farm all the three species. A large 2.7 million litre capacity pool has been constructed for the gharials.

Economic potential

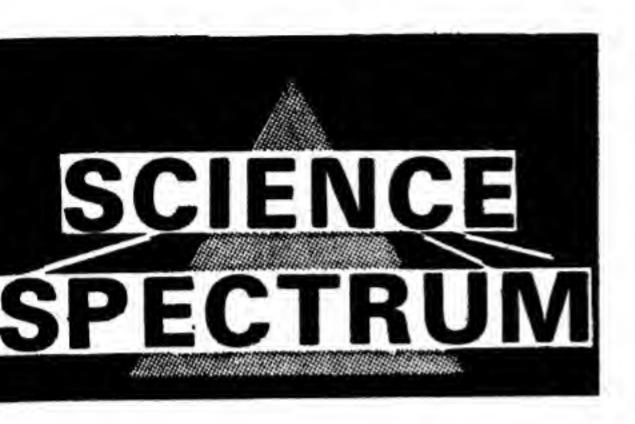
Crocodiles reared for commercial purposes are slaughtered at the agon of three years. However, the case with gharial may be quite different The demand for the skin was the cause of extensive illegal hunting. The skin is used for making shoe bags and belts, etc. The tribals extensive meat. The meat is believed to be a cure for asthma.

Though we think that crocodile are voracious fish-eaters and ar detrimental to fishery, the truth somewhat different. Firstly, crocodile do not eat much food. Secondly they live mostly on coarse fish which are predators to other fish, fish fi and fingerlings. Also, crocodile are known to feed on fish-eating birds. It is interesting to note the others are now abundant in Corbe National Park following a market reduction in mugger-gharial number Others are very destructive to fisher because they kill three times th number they consume and eat muc more than crocodiles do. Sma crocodiles (not gharials) eat man invertebrate predators of fish fr and fingerlings. Examples of suc invertebrates are the giant water bug (Belostomidae), nymphal drago flies and voracious water beetle (Dytiscidae), etc.

Future of the crocodilians

In India several states are not active in conserving their last croco dilian populations. Presently, mos notable are Orissa and Uttar Pradesh

Among the Indian crocodilians the status of the gharial is most threater ed. Let us preserve these gharial of elegant golden look!



Solar system—origin, and smaller bodies

PINY drops of water make an ocean. This proverb, which is ased on a terrestrial observation and frequently used in literature, now eems valid even beyond the perithery of our earth. Astronomers ow say: "Tiny bodies of matter take the solar system, or for that matter, any star system."

Until recent years smaller bodies the solar system were of little ignificance to astronomers. Their ttention was drawn towards objects igantic in size and complex in mystery. The origin of energy in stars, tructure of galaxy, nature of the iniverse as a whole, etc., were some problems they were busy with. The iny chunks of matter lying in our backyard as satellites, asteroids, comets, meteroids, planetesimals, and what is known as "space debris" escaped serious notice.

Although some smaller bodies have been known to astronomers for ong, the interest in them revived only recently—partly due to interplanetary probes and partly due to the development of infrared spectroscopy in World War II. The data gathered from these studies revealed similarities between the smaller and

the bigger bodies. For instance, the surfaces of planets that we could study and those of smaller bodies were found to have many craters. An ordered sequence has been found between the bodies of the solar system and the planetary systems. Just as the sun has inner smaller planets; larger outer ones, and then the irregular comets, the planets too have small inner satellites, large intermediate satellites, and then the outer irregular satellites. These two similarities have particularly caused a stir among the astronomers: Does there exist a link between the lesser and the bigger bodies? Could this link tell something about the past? It should-just as analysis of a drop of water reveals the history of the ocean it has been taken from.

Origin of the solar system

The latest model (Scientific American. Sept., 1975) has been an outcome of the studies of the bigger and the smaller bodies in respect of their mass distribution, chemistry, cratered surfaces, and arrangement about the sun. How the model accounts for every type of the bodies, particularly the smaller ones, has to be seen.

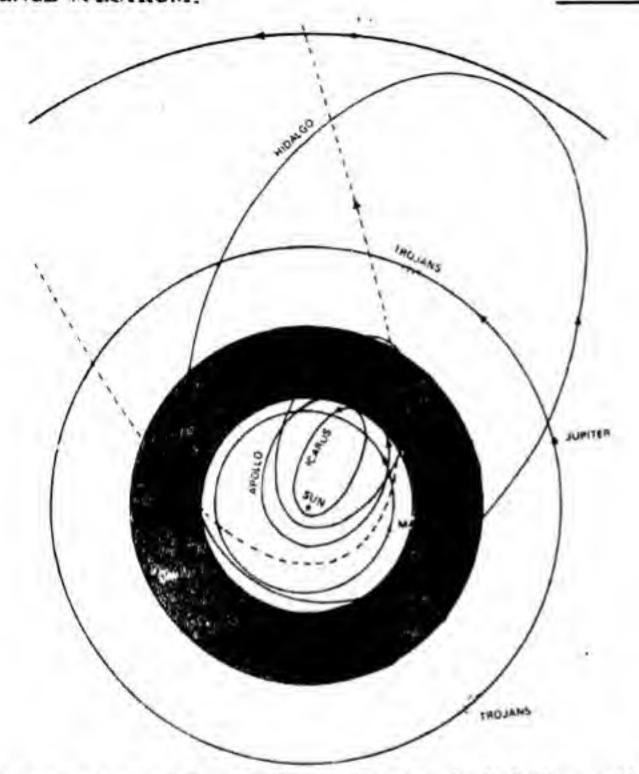
It has been observed that mass distribution is statistically irregular among large bodies. With the decrease in size, there appears a uniform pattern. Why is this so? Two facts provide clues to this pattern. First, due to collisions (we presume there were, violent collisions during the birth of the solar system) a body. depending upon its mass, breaks into a number of pieces. The larger the body, less is the likelihood of its losing much mass by collision with a smaller body. If the other body is also large, it would break into a smaller number of pieces than the number of pieces a smaller body would break. Secondly, the larger the body the more massive it is Hence, it is gravitationally highly potent. As the size increases, the body grabs more of smaller bodies in its sphere of influence from the surrounding space.

It is clear that a body, after having acquired a threshold mass, would continue amassing matter until i becomes a planet. That is why the large planets are overabundant in mass. Those bodies which did no reach the threshold size might have been shattered into smaller pieces of dust. In so far as the chemistry of the bodies is concerned, it is enough to say that it depends mainly on the local temperature and gravitations field (for details, see Origin of solar system, S.R., Oct. 1975).

The model

The model is not a hypothesis based merely on logical assumption. There are evidences in the universithat support it. It deals not only with the formation of the solar system but also every kind of star system that exists in the universe.

Consider three systems, A.B and C, where cooling dust clouds (nobeliae) are evolving around hot stars. However, all the three have a different initial condition: micro-sized dust present in system A in the lower amount, highest amount in system C, and intermediate amount in system B. Some young stars covered



artially or totally by infrared emittig cooling clouds have been obsered to be in such states. It is belieed they are evolving planets or maller bodies.

With the passage of time, the micon-sized dust coalesces to form subilometer sized bodies. They either reak or coalesce to form small articles or larger kilometer-sized odies as the case may be. As the rocess runs, bodies of varied sizes, aving different velocities, are fored. These asteroid-like entities, ecause of close approaches, alter ach other's orbit and, because of ifferent relative velocities, interact collide and coalesce. So there nsues a see-saw competition beteen the process of fragmentation Those bodies nd coalescence. hich have acquired a threshold mass ecome planets, while the rest reain as smaller bodies.

In system A, the bodies would not grow more than a kilometer in size. The star in such a case would have only a stream of smaller bodies moving around it. In system C, the bodies would grow to immense sizes. The star would have only planets, no smaller bodies, and, moreover, it would not be alone; the system would have two or more stars together. Such multi-star systems, which form almost half the stellar population, would have such planetary systems, so claim the astronomers.

The outcome of system B would also be intermediate of the above two systems. It is representative of our solar system as it contains smaller as well as larger bodies. The reason for the presence of the asteroid belt and irregular comets, of which the evolutionary process does not throw light on, has been given by Ernst Opik and a group of scientists.

Though Opik has accounted for the presence of irregular comets an other scientists have explained th asteroid belt, all have attribute these bodies to the gravitational fiel of massive Jupiter. The irregula comets, according to Opik, are th bodies at the outer rim of the sola system which when still cold wer scattered by Jupiter further awa from the sun in the early stage of evolution. As Jupiter scatters plane tesimals outwards, it also divert some of them towards the inner sola system. A large number of ther scattered to a point between the or bits of Mars and Jupiter, where lie the asteroid belt, would not allow moon-sized body to remain unaffect ted and alone. They would ince santly bombard it to produce swarm of smaller bodies, as th asteroid belt is.

What became of those bodie which could neither become planet nor an asteroid or comet? They were influenced b planets to either collide with their to produce craters or shatter the satellites producing rings (just a around Saturn) or become the satellites. Lastly, those unfortu nate ones, which strove to grow bu remained micro-sized when the evo utionary process was near the en were either influenced by the su to merge with it (Poynting-Robertso effect: small orbiting particles whe exposed to radiation have a net in ward flow) or were thrown out int the interstellar space to be referre to as interstellar dust.

Here it is pertinent to mention that until recently the presence of interstellar dust in space that recently the stars was unaccountable it is because the interstellar space contains too less atoms to coaler ce and form dust. Now, it is obvious from the above discussion that the source of this clust is, in fact those young stars where the property of the source of

off and on, dust is thrown away as arbage that accumulates in the aterplanetary space due to colliding lanetesimals. Solar wind is like broom which sweeps clean the olar system of this garbage.

It is now easy to explain that ne-

maller bodies

ulae dust settled down to make the olar system. We will at present iscuss only the smaller bodies preent in the solar system as satellites, steroids and comets. Here and here, some anomalies are present. hey are still beyond comprehension. Moon. This satellite of earth is nusually large compared to its earer. As its material tallies with hat found on the earth's surface and ot with that inside, it is claimed to ave originated from the earth. he impact of a large body knocked out of the earth some hundreds f million years ago and since then t is in its orbit. In the initial stage, crust enveloped it due to partial eating and melting. For the first 00 million years of its life, it was eavily bombarded by planetesimals, ome even more than 100 km in liameter. About four billion years go, the bombardment declined and ome parts of the cratered primeval rust melted and lava inundated it. Even today the bombardment is on, hough it has diminished considrably.

In Canada, some terrestrial fossils of craters have been found by geoogists to be about a billion years old.
Taking into account the earth's grarity the intensity of meteoroid bompardment has been found nearly the
same as that found on moon during
the same period.

Apollo asteroids. It is a group of asteroids, named after one of its member, that sometimes intersects the orbit of earth round the sun. There always lies a random probabi-

lity that any one of them gets deflected off its path to crater earth or moon. Toro, one of its members, has been found to have chemical properties similar to those of L-type chondrite meteorites that have cratered earth. It is now claimed that the source of these meteorites must be Toro. Some pieces might have long back been knocked off it, that consequently cratered earth. Studies are, therefore, in progress to link the origin of meteorites to asteroids.

Satellites of Mars. Though its two satellites, Phobos and Deimos, have been cratered, they do not theoretically seem to have been captured "fugitives" from the next-door asteroid belt. It has been theorized that they are the remains of a satellite that was once orbiting the planet.

Asteroid belt. In accordance with the Bode's law of spacing, the asteroid belt—a swarm of smaller bodies between the orbits of Jupiter and Mars—is closer to Mars than Jupiter. These are the bodies which never reached the threshold size during the evolution to accumulate mass and form planets.

Ceres, the biggest amongst them, almost twice the size of the second biggest asteroid, Pallas, having a mass equivalent to sum of all asteroids, is taken as an advanced planetesimal that had reached the threshold size when the evolutionary process stopped or was about to conclude.

From the spectroscopic studies, the asteroids can be categorised into two classes: those which are stony iron and those which contain carbonaceous chondrites.

The stony iron ones, which form the ten per cent of entire asteroid population and which are nearer to Mars than asteroids of the other class, are considered as the remnants of metallic cores of disrupted planets. It is a well-known fact that during the evolution, bodies were regularly heated and melted, so a to segregate into heavy and light materials; while the heavy material settled to the core, the light on surfaced. When such a body was continuously shattered, the oute material got chopped off, leaving only the iron core. At the terminal tion of, or during the evolutionar process, these iron cores were grave tationally influenced to flock to gether in the asteroid belt.

The carbonaceous chondrite as eroids contain even water in abur dance in various chemical forms As the chemical composition of thes bodies is similar to the materia which the dust cloud that created th solar system formed, these bodie are those remnants that were affect ted neither thermally nor chem cally. They were neither broke by collisions nor were large enoug to get heated from inside. The retained their original primeval ma ter. This explains the existence of the asteroids of this type.

Trojans. In the Jupiter-sun sy tem, these are two groups of plant tesimals that lie nearly at an ang of 60° (considering the sun as the centre of the angle), before and after the Jupiter. In addition, there are twice as many planetesimals ahea of Jupiter as behind it.

The presence of these bodies had been accounted for by calling them a debris. It is the residual matter left after the formation of Jupite or the accretional matter left in the interplanetary space gravitationally trapped in by Jupiter. The presence of these planetesimals was predicted on theoretical basis by J.L. Langrange, an eminent mathematician, though it was only after a century of his death that the first Trojan was detected.

Satellites of Jupiter. This plane has three groups of satellites, in a numbering thirteen. The innermos group has five satellites, of which Io has been a subject of controversy for a century or so.

It has been observed that the surface of lo brightens up for a short time as soon as it emerges from the shadow of Jupiter. Today, this effect has been attributed to the change in colouration of compounds, perhaps, of sulphur, on lo. This effect is caused by their exposure to sun. Further, radio astronomers have found a distinct correlation between the radio burst generated by Jupiter and the position of Io with respect to it. The approach of Pioneer-10 to Jupiter in 1973 has revealed an ionised layer about 100 km above lo. So, it is inferred that radio bursts are generated when the ionised layer of lo disturbs the magnetic field of Jupiter. In 1974, Robert Brown of Harvard University, U.S.A., discovered that lo emits a yellow glow characteristic of the D-line of sodium. Sodium atoms prevalent on the surface and in the atmosphere of lo scatter sunlight to create the glow.

The other inner satellites, Europa, Ganymede and Callisto, have also been studied. To the surprise of the astronomers, they are different in composition from one another. Unlike Io, they are mostly covered with soil and frost. Callisto is the darkest among them, because more of its rocky material is open to review than in the case of others.

The next two groups of satellites are still a puzzle for astronomers. They are unlike innermost satellites: their orbits are inclined to the equatorial plane of the planet; instead of being distributed equally around the planet they are in clusters; they move in retrograde direction opposite to the inner group. Astronomers attribute the existence of such objects to special processes that captured them from the surrounding space. The processes are called 'special' as they allured (reasons unknown)

one planetesimal to join one group of satellites and another one to another group. Z.A. Aitekeeva, a Russian astronomer, has suggested a different reason for the anomaly. According to him, these groups are the shattered remains of bigger satellites. In the early days of the solar system, a comet or an errant Trojan might have caused this.

Saturn: satellites and rings. The largest satellite of Saturn is Titan, nearly 5,800 km in diameter, which suggests that it may possibly be the largest satellite in the solar system. As seen through telescope, its surface is always covered, partially or totally, with reddish brown clouds. The atmospheric pressure on its surface is nearly one-tenth of the atmospheric pressure on the surface of the earth; the temperature is 125 K, and the surface, it is believed, is covered with ice. The atmosphere contains mainly methane and hydrogen. If, in addition, there is geothermal or volcanic activity prevalent on the satellite, there is bound to be present temporary pools of water. On having suitable temperatures, the formation of amino acids could take place there.

While Titan is of biochemical interest to science, lapetus, another satellite of Saturn, holds the attention of scientists because of the mystery about it. It has been observed that one side of the satellite is six times brighter than the other-while one side reflects light less than what a blackboard does, the other shines like snow. Various plausible explanations have been offered, but a recent one, forwarded by Steven Soter of Cornell University, is widely accepted. Poynting Robertson effect, (mentioned above), he claims, brings about this effect. Some material from Phoebe streams in towards Saturn, and when it intersects the path of lapetus, it rains down causing unusual erosion and dust accumulation or

both. It makes the surface nor reflective, while the other icy region remain unaffected.

The rings are the unique feature about Saturn. Spectroscopic studies reveal them as thousands of satellites, each nearly a few centimeters is size, covered with or composed of ice. On the whole, the rings are about 270,000 km in width and about a few kilometers thick. An interesting aspect is that the bodies is the rings are so arranged that in the first place they do not collide with each other and, secondly, there are gaps among them due to the gravitational influence of nearby satellites.

The creation of the rings is sti a redoubtable issue for the astro nomers to comprehend. Some clair that rings were formed in the earl days of planetary evolution—the rem nants of pulverised satellites one orbiting Saturn. Others claim ther not be so. The rings, accordin them, are still evolving. They ar the result of collisions that are sti taking place between planetesimals i the interplanetary space. The bodie so created are gravitationally swep in by Saturn to form the rings.

The subsequent major planets as so far away in the space that they an their entourage have not yet bee thoroughly studied. It has bee observed, however, that billions of smaller bodies, whose sizes vary from tens of meters to 100 km, move roun the sun in the outermost region of th solar system, as distant as thousand of astronomical units away. Thes bodies when perturbed by the gravit of planets or stars (sun) enter the inne solar system. Once inside, they ar accommodated by planetary influen ces to form asteriods in the main bel or Trojan or Apollo group. Or, i massive, they may even become co mets, the irregular visitors to the solar system, one of the best and conspicuous examples of gravitation al influence. DILIP M. SALW

The discovered "monopole" on trial

CINCE 1931 several attempts have D been made to detect the magnetic monopole. In the February 1976 ssue of Science Reporter, T. Chakraporty has discussed in detail the reported discovery of the moving nagnetic monopole in cosmic rays in balloon flown in the U.S.A. using plastic-emulsion-film sandwich stack. The event was a single one. In the oox accompanying the article, it as been stressed that if only here is no other interpretation ossible for this event, one can take he evidence as conclusive. In the March 1976 issue of Science Reporer, R.K. Datta has expressed a doubt bout this interpretation. He quoed the alternative explanation of this vent-as due to an interaction of a osmic ray platinum nucleus fragnenting into a tantalum nucleus in he Lexan stack. This explanation vas given by Prof. Luis Alvarez of Iniversity of California, Berkeley, J.S.A. (1975), a Nobel Prize winer in Physics. He criticized Prof. rice's claim of the reported discoery suggesting that his interpretaon is both possible and probable. le also added that when one is posulating something highly exotic and xciting thing like a magnetic monoole, one should exhaust all other venues of interpretation before nnouncing the discovery. As an xample, he quoted the discovery of he positron by Prof. Carl David inderson of California Institute of echnology, Pasadena, California, J.S.A. (1932). The positron event as also a single one but Prof. inderson took pains to see that here are no possible errors involved ither in measurement or due to astrumentation. Prof. Alvarez, on he other hand, has detected an

error in the thickness measurement of Prof. Price's experimental stack. This error is in the right direction and has increased the probability of his interpretation. Since then, three articles have appeared on the magnetic monopoles in the Proceedings of the 14th International Cosmic Ray Conference held in August 1975 at Munich, Germany, besides a revised version of the original paper published in the Physical Review Letters. From these articles we learn the following: (1) Prof. Price and his colleagues have now given the correct thickness of the sheets but still argued what they have encountered was a magnetic monopole; (2) Prof. A.L. Hodson of the University of Leeds, England, has gone into the details of the recording efficiency of the cerenkov film (one of the 3 detectors) that these authors used in their work and gave a different view of the event; and (3) Prof. P.H. Fowler of the University of Bristol, England, has tried to investigate carefully the measurements made in the nuclear emulsion and plastic stacks (the second and the third

detectors used). As a result he has given another interpretation of the event somewhat similar to what Prof. Alvarez gave.

There are two parts in the analysi given by Prof. Peter Fowler. The first one concerns the track in emul sion and the second the effects and probabilities of nuclear interactions in the Lexan. Prof. Peter Fowler is an expert in emulsion technique and had collaborated with the Nobe Prize winner late Prof. Cecil Frank Powell of the Universty of Bristol England (1950), in the initial stages of the development of the photographic emulsion technique. He had also collaborated with Prof Buford Price in the discovery of transiron elements (Iron to Uranium) in the primary cosmic rays which was done using giant nuclear emulsion stacks flown in balloon flights in the U.S.A. He has examined emulsion data presented by Price in detail. It may and others mentioned here that the blackness of the track produced in the emulsion and its variation with distance gives a measure of the ratio Z^3/β^2 (the square of the ratio Z/β), where Z is the nuclear charge and $\beta = \nu/C$, ν and C being the velocities of the particle and light respectively. He was of the view that from the track profile measurements in

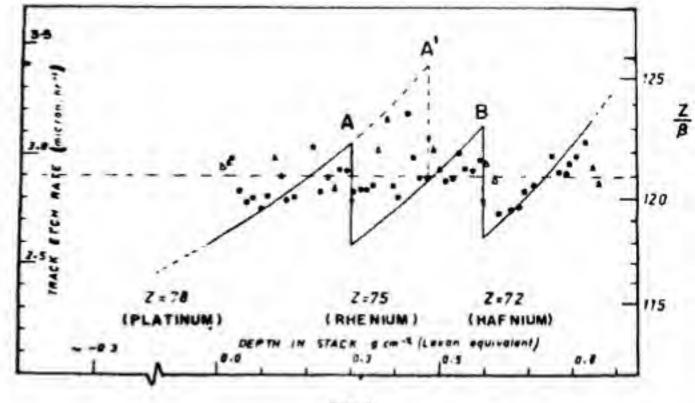


Fig 1

emulsion, one can only conclude that the particle was a fast one with velocity V > 0.45C and Z/β having value of 120. This would remove one of the important planks upon which Prof Price and his colleagues based their monopole interpretation. le further remarked that the overall constancy of 1/3 around 120 in he Levan stack as observed by the discoverers was due to a chance coincidence. He interpreted the event in Lexan as follows (Fig. 1). A primary nucleus of charge /. 78 platinum nucleus) and with \$ 0 66 first suffers a nuclear interaction ei her at A or A'l and becomes a nucleus of charge Z .- 75 (Rhenium nucleus). Three protons are emitted in this process. The B value of the nucleus here is 0.63. This nucleus suffers another interaction at B and becomes a nucleus of charge 72 (Hafnium); and three protons tre emitted in the process. Here ts fi value is 0.60. The nucleus inally leaves the stack as a Hafnum nucleus with a B value of 58. The horizontal (dotted) line s the line drawn by Prof. Price and others, which fits for all he black dots and triangles (these denote the actual measurements nade by them). The black lines with extended dotted lines) are the ines drawn by Prof. Peter Fowler o fit all the points. So one can asily see the difference in pointsf-view.

Prof. Peter Fowler's view of the vent is that the primary particle (a datinum cosmic ray nucleus) passed brough the cerenkov film (first letector) without producing radiation. As a result β value at the erenkov detector was less than 0.68 the particle then passed through the mulsion (2nd detector) leaving a rack having a Z/β value of 120 and greater than 0.45. Finally, the particle entered the Levan stack and detector) as a platinum nucleus

with β=-0.66, then interacted twice in the stack and left it as a Hafnium nucleus with β 0.58. These measurements taken together permit the interpretation in terms of the break-up of a cosmic ray platinum nucleus into a hafnium nucleus. Prof. Fowler is of the view that, considering the large number of cosmic ray very heavy nuclei observed by Prof. Price in balloons so far, the probability of observing one such event is not quite low.

Prof. Hodson explains the event as due to an interaction of a very highly energetic primary cosmic ray nucleus just above the stack. He calculates that in the interaction about 10⁴ secondary particles are produced at a very narrow angle (~5×10⁻⁴ radians). These probably contain equal number of positive and negative charges over a small area and are almost equivalent to a beam of neutral particles. The emission of Cerenkov radiation is hence suppressed when these particles pass through the Cerenkov de-

probability of observing this event low (one in a million). The interpretations of Prof. Peter Fowler an Prof. Alvarez are cogent and have higher probability of occurrence.

So where do we stand now? D we have to remain in doubt for year to come? Fortunately not so. Bot Prof. Price and Prof. Fowler hav agree to pool all events of heavy slow cosmic ray nuclei recorded i emulsion stacks at Dublin, Housto and Bristol. These events includin that of the monopole, will then b studied in Houston and Bristol wit their respective techniques as a mordetailed experimental check. It is also said that Prof. Price is planning to get a few more events of the kind by flying plastic detectors at high altitudes. Let us hope that within the next few years we will learn more about monopoles as to whether the really exist or not.

N. DURGAPRASAL Tata Institute of Fundamenta Research, Homi Bhabha Roue Bombay-10000.

Evolution of continents and oceans

THE origin of life is still a mystery A long period of development of carbon compounds leading
upto ammo acid and protein must
have preceded the origin of the living matter. The catalyst or combining agents such as clay minerals
must have played an important
role. The earliest organism presumably lived in water without free
oxygen. They may have been similar
to certain one-celled plant of the
present day, which flourished in the
absence of oxygen.

The first uncellular animal 'amoeba' came into existence in the sea. The bacteria were the first to emerge in the plant kingdom. Since 600 million years onward many unforgettable changes are happening in this planet.

Can one imagine the past position of all the continents when they were just like a compact mass of land. There were no huge mountains, no rivers, no plateaus, no big cities and no recreation centres of today except the sea and the continuous land mass. Since the advent of man, say one million years back, various theories for the separation of the sea and the land and the transformation of the present day continents have been proposed.

Sixty-one years ago. Alfred We gner, a German meteorologist published a new theory of "Continenta drift"—separation of all the conti



Fig. 1, 200 million years ago: Pangaes-a single super continent



Fig. 2. 135 million years ago: Splitting of Laurasia from Gondwanaland

ents as they are today. The first dition of his book Die Entstehung der continente Und Ozeane appeared in 915. His theory that the continents of outh America, Australia and Africa ad formed as one continent of condwanaland was appreciated and ollowed by many geologists and alaeobotanists. Prof. Birbal Sahni ad also accepted his proposed neory of continental drift. Later on, n American geologist concluded on he basis of tectonic changes that a onsiderable redistribution of the ontinents had taken place in geoloical past.

Until the nineteenth century, cientists believed that the earth had been created only a few thousand tears ago. With so little time

available for the formation and development of earth many scientists believed that sudden and violent forces of catastrophe had shaped the earth surface. This theory was called Catastrophism. Some catastrophisms were fully satisfied that canyons were simply giant cracks in the ground formed during a series of violent earthquakes, and the tidal waves and the floods were caused by huge meteorites or comets that struck the earth.

Other catastrophists postulated that the thick sequence of sedimentary rocks in the earth crust had been deposited during the worldwide flood depicted in the Bible as Noah's flood. They thought that the fossils found in these rocks were the remains of organisms killed by the flood. Still others realized the difficulty in accounting for the apparent changes in fossils from older to younger beds with only one flood.

Most of the catastrophist's proposal were related to observation of natural events. They were however distorted by gross exaggerations in scale. The uplift and the subsidence of the crust occur at a very slow rate. Earthquakes do cause cracks in the earth but the width of such cracks is generally not more than a few moters. Floods are common but are always limited in extent.

In eighteenth century, the Neptunist School of thought (believer in the origin of rocks as chemical precipitates from the sea) adopted a theory

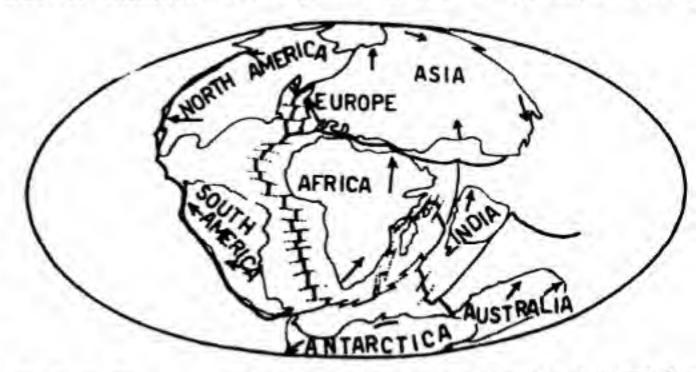


Fig. 3. 65 million years ago: N. Atlantic and Indian oceans take shape and Sout Atlantic widens. Australia still attached to Antarctica

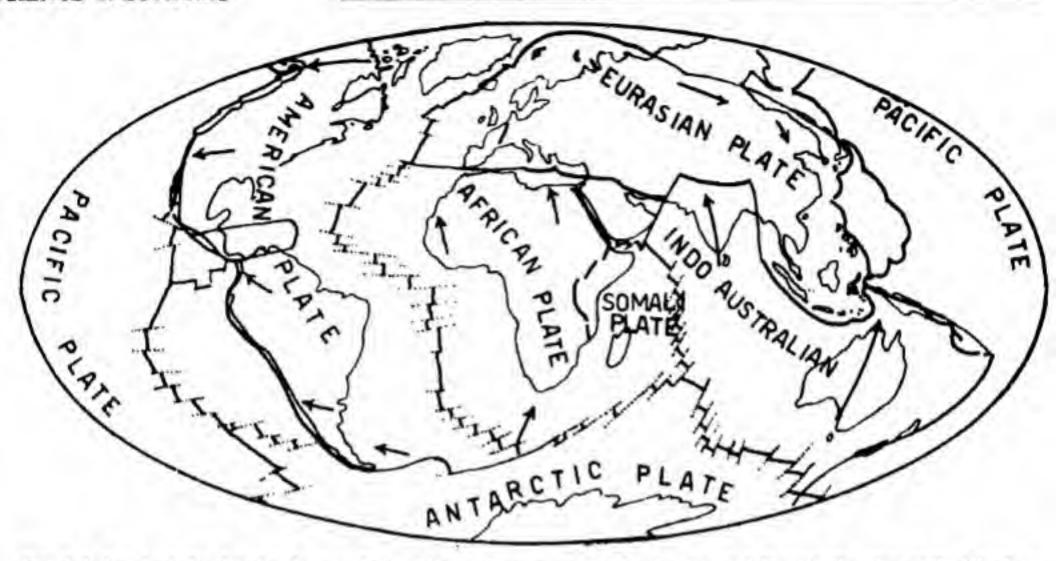


Fig. 4 Today: Australia detaches from Antactica, Laurasia separates into N. America and Eurasia, thrusting up the Himalaya

on the basis of which majority of the earth rock had been chemically precipitated in a universal sea. The oldest formations of the earth are very primitive. It consisted of granite mixed with geniss (coarsed grained netamorphic rock), chist (crytalline foliated metamorphic rock) asalt (igneous rock) and marble. The overlying strata also consisted mainly of precipitates but included ome sediments weathered from the primary islands that were exposed as the sea retreated. According to the

Neptunists as the water receded further, sandstone, conglomerates, limestones, chalk and coal became more abundant.

The geologists were not satisfied with the theory of Catastrophy. The Neptunists and the Geologists believed in the uniformity of the nature. They reasoned that the development of the earth crust could be best understood by observing geological processes of today.

In 1788, James Hutton, a Scottish geologist. in his contribution on the theory of the earth, pointed out that most of the geological phenomena could easily be understood through careful observations of modern processes and that all the geological processes that operate in the past also operate at present The phrase "The present is the ket to the past" sums up the concept of Uniformatarism (a doctrine that geological changes were brough about not in the main by great convulsions but by such action a may be seen going on now).

In the later part of the eighteent century, William Smith, a Britis surveyor, while supervising th building of a canal in England, trace certain rock units over hundred of square miles and found them i the same sequence. Later on, h travelled through the country an noticed that the same strata wer found always in the same orde and contained the same time of fossils. These observations gav rise to the principle of faunal an floral succession through geological times and the correlation of th



Fig. 5, 50 million years ago, the Mantin and Indian Oceans continue to widen, the Mediterranean shrinks (After Mathews)

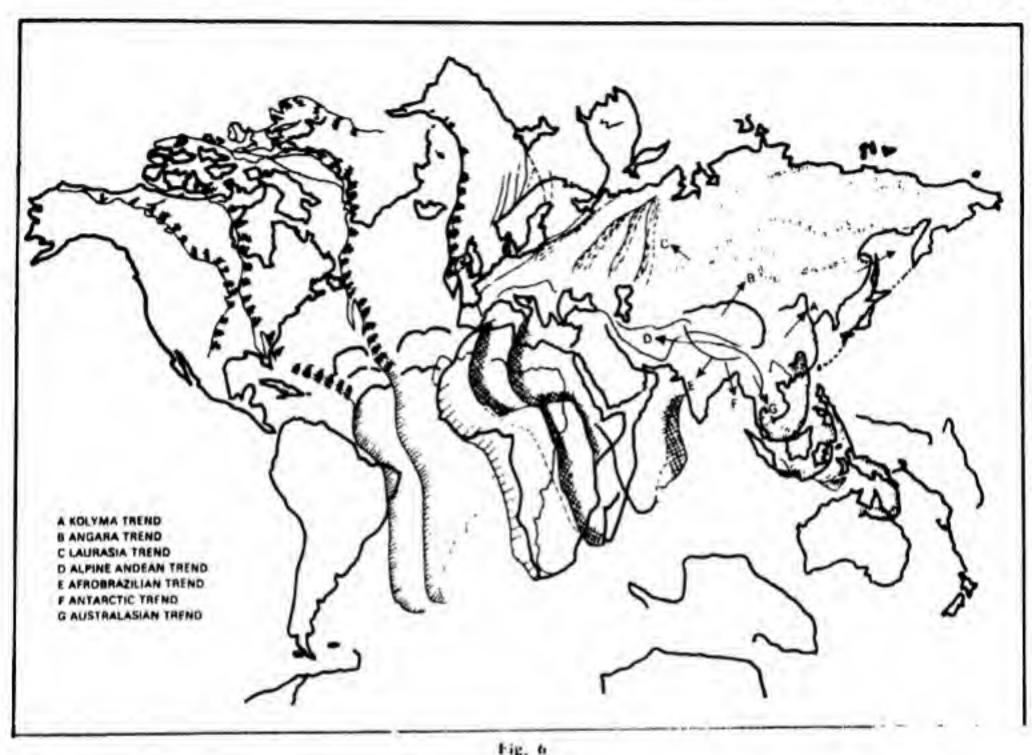


Fig. 6

ocks' sequences based on such ossil assemblages. On the basis f lithological characters of the rocks nd fossil contents as a means of acing strata, William Smith was ble to publish a coloured geological ap of England, Wales, and a part f Scotland.

About 200 million years ago, there as a complete single supercontinent ow called Pangea (all land). It was urrounded by a universal sea known s Panthala sea on the east and ne west corners. The Pangea was iter washed away by the ocean urrents.

As time passed, say in 135 million ears the northern land mass known s Laurasia had split away from outhern part known as Gondwaaland. It was named after a eological region of Madhya Pradesh, ne time inhabited by the Gond

tribes.

The northern part of the supercontinent forming Laurasia is comprised of North America, Europe and Asia. The Gondwanaland has also divided with India heading north Eurasia. The North towards Atlantic and Indian Oceans took shape and the South Atlantic widened a little. At that time Australia was still attached to Antarctica (65 million years ago).

Today, as evident from the global distribution of continents, Australia off from Antarctica. was torn Laurasia finally separated into North America and Eurasia India has turned over on the side into Eurasia thrusting up the Himalayas.

Millions of years ago south American plateau was adjacent to African plateau. North America also occupied a position close to Europe, New Foundland and Ireland.

The old hypothesis of Pangea a supercontinent and its subsequen break up into northern regions the Laurasia and the souther landmass -the Gondwanaland -wa popularized under the name of "The theory of continental drift".

Recent concepts based on explora tions are quite different from that o Wegner's hypothesis. It was though that there was one more Atlanti sea before the formation of Pangea On the south of it was situate Africa, which later broke off from Gondwanaland and moved toward north. It then collided with th northern landmass to uplift th Applachian mountains of Nort America and Caledonian mountai chains of Scotland. At the sam time. Europe and North Americ (Eurameria) were lying at one sid of the ocean, whereas Angara was on the other side. Europe then left the association of North America and moved gradually lowards Siberia. Their collision uplifted the Uraal mountain.

In the meantime Gondwanaland was also broken into various pieces spreading in different directions leaving Antarctica in the South. Australia sailed towards east. Africa moved northwards whereas South America slipped westward. The last remnant, India, was also thrown towards the north.

Many geologists, palaeontologists and palaeobotanists have supported Wegner's theory of continental drift on the basis of their geological, palaeoclimatological, geochemical, palaeontological, palaeobotanical as well as palaeomagnetic researches. All these aspects are closely related with each other and have a correlated impact on the problems of continental drifts. Recent appliances and heir applications have paved the way for confirming the continental hanges that happened from time o time.

A research ship, The Glomar Challenger, was able to take out samples from 6,000 mt. deep oceans. The core hole cores taken out from the surface were saturated with the micro-lements of the past. These elements could help in establishing the correlation of various plant groups and their surroundings.

The development of a precise physical method for the measurement of latitude and orientation palaeomagnetism) has revolutionised the field of continental rift. Palaeomagnetic studies have roved to be quite helpful and ave established the fact that rocks were formed by deposition of ifferent sediments of varied chemical nature and by cooling of lava. If the rock particles are magnetic, they will remain suspended, and tend

to have a north-south orientation in relation to earth polar axis at the time of rock formation.

The palaeomagnetic studies have shown that nearly 450 million years ago, the Sahara desert which is 30° north of Equator must have been at the south pole under a polar ice cap. It has also confirmed the existence of Pangea about 250 million years ago and the splitting of Laurasia and Gondwanaland about 200 million years ago, followed by the separation of North and South America.

Some geologists collected the rock samples from different geological periods and varied land masses of Laurasia and Gondwanaland and matched their colours, observed their textures and chemical compositions and inferred their similarities in a definite strata.

Chemical information also gives weightage to the theory of continental drift. The study of radiometric ages of rocks from different continents furnish relevant information and support the drifting of these continents in the past.

Geochemistry has also helped in comparing elemental configuration of different rocks. On the basis of their similarities in elemental constituents, the drifted continents may be related to their parental blocks. Tracer elements like magnesium, iron, cobalt, silver bismuth, etc., may yield relevant information to explain the drifted

movement of the continents.

As regards plant fossils, they served as a tool to know the past distribution of plants. Palaeobotanic information becomes exceeding important in the interpretation of drift mechanism in continent Many palaeozoic plants occurring in Europe and North America are no known to be identical.

Dr. K.P. Rode, a geologist of Udaipur University (1953) propose a new theory, popularly known as "Sheet movement theory" It helped to prove drifting among the continents. He was of the view that all the continents have expanded by repeated movements of sheet closely placed, like playing cardipled up together within the region of central Asia.

Another renowned Indian geologist of Aligarh Muslim University Prof. F. Ahmad (1967) (now Commissioner, Dept. of Geology & Mining, Jammu & Kashmir State), mad a brief comparative study of the geological formations of Wester Australia and Peninsular India and its bearings on the drift hypothesis. He was of the view that there were similarities in rock types mineral occurrences, climate, glacia tion, fauna and flora.

J.C. SRIVASTAVA
ANIL CHANDRA
Birbal Sahni Institute of
Palaeobotany Museum
Lucknow-7, U.P.

Plants are world's natural pollutant sink

PLANTS fix and metabolize carbon dioxide (CO₂) with the help of chlorophyll, a green pigment present in the leaves, and light (i.e., photosynthetically); and in dark CO₂fixation reactions (i.e., nonphotosynthetically). Plants fix and metabolize carbon monoxide (CO) also in light and in dark. But this has not yet been extensively studied. That CO is assimilated by green plants has been known since the reginning of this century. In 1903, ome workers reported that Nasturium leaves produced starch from CO n COs-free atmosphere, when illuninated. But it was only after the liscovery and use of a radioactive sotope of carbon with atomic mass 4 (14C) in metabolic processes hat some aspects of CO metabolism n green plants were unveiled. Usng 14CO, A.R. Krall and N.E. Tolbert (1957) of the Oak Ridge National Laboratory, USA for the irst time showed that 14C from 4CO is fixed mainly into an amino cid serine. They also reported that O fixation is light dependent and ery low light intensity (i.e., 10 footandle to 20 foot-candle) is required o attain maximum rate of CO ixation. They suggested that the eduction of CO takes place on the nzyme cytochrome oxidase at the ime of dissociation of its complex rom the enzyme in the presence of ight.

In subsequent studies several worers contradicted the findings of (rall and Tolbert (1957); they sugested that CO, not serine, is the rimary product of CO metabolism. hese workers examined the soluble roducts of CO fixation and conluded from their observations with hose of CO, fixation that CO is netabolized mainly after its oxidaion to CO. However, recently R.G.S. Bidwell and D.E. Fraser 1972) of the Queen's University. Canada suggested that CO is mainly ixed into serine in light. Much of he CO goes through the serine athway to sucrose and not fixed is CO, by normal photosynthesis. hey argued that if CO were convered into CO, and then fixed as such, he 14C distribution among the proucis of "CO and "CO, fixation hould be similar. But there are arge differences. The major insouble product of CO, fixation is tarch while that of CO fixation is

protein as would be expected if the main product of CO fixation is an amino acid. However, not all CO carbon goes by this way. They have given evidences that at least a small proportion of the CO is converted into CO, and metabolized as such.

Carbon monoxide can be fixed by green plants by two different pathways; reductive pathway and oxidative pathway. In the reductive pathway, the entry of CO into serine may be mediated by the formation of a CO-derivative, tetrahydrofolic acid, which becomes reduced. This pathway is the major route of CO assimilation in light. Photosynthetic reducing power may be used for this pathway. However, the formation of some serine and sucrose in dark suggests that at least a small amount of CO is also absorbed and metabolized by the reducing pathway in complete darkness in light. In the oxidative pathway, CO is first oxidized to CO, and then fixed as such or released into the atmosphere. The labelling of an amino acid aspartate indicates that CO, derived from CO is fixed by the normal dark fixation process. The oxidative pathway mainly takes place in darkness. The fact that the rates of reductive uptake of CO in light and oxidation in darkness are about the same suggests a common absorptive system for CO in plants.

The uptake of CO has been reported for a number of plants such as Allium cepa. Avena sativa, Coleus blumei. Cucumis sativus, Daucus carota. Fagopyrum esculentum, Medicago sativa. Phaseolus vulgaris, Triticum aestirum, Zea mays, Saccharum officinarum and several other plants. The uptake of CO by plants varies widely with species, but is not related to the rate of photosynthesis. On the basis of the first product of photosynthesis, plants are broadly divided into two groups:

those plants producing oxaloacet acid (a 4 carbon compound) at known as C₁ plants, and those producing phosphoglyceric acid (carbon compound) are known as C₂ plants. Most of the tropical grasses belong to the forme category (C₁ plants). They have higher rate of photosynthesis. Most of the temperate species belong to the later category (C₂ plants). The have a lower rate of photosynthesis But C₄ plants do not as rapidly metabolize CO as the C₄ plants.

The fixation of CO by plants is t great importance from the point a view of atmospheric pollution because CO is a serious atmos pheric pollutant & especially in th cities. It combines with the ferrou ion of cytochrome oxidase which accounts for the extreme toxicity of this compound to living orga nisms. The average CO concentra tion in air over the land masses ha been found to be in the range of 0.1 ppm to 1.0 ppm. However, in cities the average CO concentration is 5 ppm to 9 ppm with the maxi mum value reaching well over 10 ppm in the most industrialized cities R.G.S. Bidwell and G.P. Bebe (1974) of the Queen's University Canada, suggest a value of 3 . 1014 global CO production per yea (Table 1). CO is produced both from physical and biological sour ces. The CO production by plants ap pears to take place primarily from

Table 1. Global carbon monoxide production (After Bidwell and Bebee 1976)

Amount, g/yea
ral
2.00×10
0.09×10
0.09×10
3×10

the degradation of chlorophyll and phenolic compounds and as by products of the synthesis of bile pigments as well as by other pathways.

Plants may be the most abundant, f not the most efficient, natural bsorbers of pollutants. The absorotion of CO by plants in light and n dark ness may constitute an appreiable global CO sink. Bidwell and Bebee (1974) calculated that in nornal concentration of CO in the air over the land masses, which is 0.6 opm on average, the total global iptake of CO by plants may be 0.31 × 10¹⁴ g per year. However, he total global production of CO is bout 3 × 1014 g per year. It is pparent that plants may absorb little over 1/10 of the total CO produced in the world. Further, they

produce twice as much as they absorb. It has been reported that CO absorption by plants increases linearly with the increase of CO concentration. Therefore, in cities where the CO concentration is appreciably higher, the rate of CO absorption by plants may be greater by a factor of 10 to 100. Therefore, the role of plants in the global CO balance is very difficult to assess at present.

MANORANIAN KAR Department of Botany, Utkal University, Bhubaneswar 751004

Professor of Botany, Revenshaw College, Cuttack 753003 the cell can be put into another organism for conducting varies studies. Cells of mice and chicken have in fact been dispersed in asertic tissue broths, and new kidney and hearts showing the mixed composition have been obtained, is punningly said of the America scientist T.T. Puck, who has been a intensive culturist of mammalia cells, that "Puck plucked his neck". A more astounding work than a

to a new site in its parent body,

these, which rather threatened the very basis of sexual reproduction came forth from Cornell University Professor Fredrick C. Steward. It 1959 Steward isolated cells from the domestic carrot and grew them is specially devised flask culture. Upon feeding the cultures with cocont water, Professor Steward could obtain an idefinite number of carrot plants. In effect Professor Steward had bypassed the sexual process of obtaining carrot plants through seed formation.

Steward's work caused a stir i conventional plant embryology. has been known that in some specie of flowering plants, the egg cell car directly develop into an embryo without uniting with the male gamete This phenomenon of dispensing with the male sex is called parthenogene sis, and more recently "gynogenesis" as opposed to androgenesis. In androgenesis the female sex is elimi nated. But a universal method o inducing either of these unisex pheno mena at will is still wanting. In plants "pollination" with abortive pollen, dead pollen, X-rayed pollen and certain other methods have been tested for inducing gynogenesis. A chemical regulation of gynogenesis has not yet been achieved. Androgenesis is a less common

'In Hindu mythology, the legend of the demon Rakta Beeja can be cited as an example of parasexual phenomenon.

Alternative to sex?

dinner conversation between A two German naturalists, Mathias Schleiden and Theodor Schvann in 1838 resulted in a great ntellectual achievement—the 'Cell Theory'. Within decades after that, he basic tenets of the cell theory ed to the birth of such branches of iology as cytology, embryology, istology, and tissue therapy. In 902 the celebrated German plant hysiologist, Gottlieb Haberlandt, iscussed the theoretical possibility f growing isolated cells of plants in rtificial cultures; but his idea was ar ahead of the technical advances f his time. Today cell, tissue, and rgan cultures and protplast (total ontents of a cell) culture are no onger impossibilities.

As a technique plant organ culure was started in 1939, when thilip. White at the Rockefeller institute, New York, and two French cientists independently and successully grew excised roots of the tomato lant in artificial nutrient medium.

During World War II, scientists

were asked whether they could obtain the plant drug ephedrine in test tube cultures of Ephedra tissue, quinine in cultures of Cinchona tissue, and rubber in cultures of rubber plant tissue. At that time, such propositions meant a dream. But today, use of cell and tissue cultures of both plant and animal species is common in biological and medical research, and in some industries related to biology and medicine. The well-known HeLa strain of human cells, for example, has still been maintained, although Henrietta Lacks, the woman from whose carcinoma the cells were isolated in 1951, died the same year. Indeed, the He-La strain has served as a basic material for studies on polio vaccine, and it has continued to be useful especially in researches on cancer.

Once a cell has been isolated from its parent organism, it can be subjected to many experimental interventions. For example, it can be returned to its original position or



Alternative to sex? That is really unthinkable for me"

henomenon than gynogenesis.

mong animals, androgenesis is
est recognized in the honeybee.

mong plants androgenesis has been
f historic value until recently. In
ne last decade, however, several
otanists, especially in India and
apan, have succeeded in raising
indrogenetic plants of rice, tobacco
and potato in test tubes.

Both gynogenesis and androgenesis esult in pure 'unisex lines' which re of paramount value in plant reeding. Recognising the usefuless of unisex lines, the Rockefeller oundation convened in 1969 a onference of a dozen chosen scien-Bellagio, Lake Como, at sts taly. The outcome—to intensify reas in parasexual research which nay help bypass sex in plant breedng. This group of scientists was uick to recognise the potential of esearch on protoplasts. Protoplast a collective term for the total ontents of a cell. Soon, techniques o enzymatically digest the bounary in plant cells to make the naked rotoplasts fuse, and to eventually ear a hybrid which would not ave been otherwise created became he obsession of the day. Although eading schools of research on lant protoplasts have sprung up n UK, Japan, Canada, and USA, he mundane problems of inducing rotoplast fusion at will, making

the fused protoplasts develop into a new cell and eventually into a multicellular organism with its myriad phenomena of growth and differentiation are still a far cry. Along these lines, encouraging success has been obtained with tobacco plants at the Brookhaven National Laboratory, USA.

But where do we go from here? Have we really achieved all that we need to with plants and animals? Whereas it is easy to tinker with the mute organisms in our universe, man does not have a similar licence to meddle with his own species. Society, ethics, religion, and politicsalthough all are man-made-often limit him from putting his intellectual ideas into action. And when, only 42 years ago, Aldous Huxley wrote about assembly line babies being decanted from glass tanks, people laughed it off as an absurd fantasy. Today, science has replaced supernatural power and fantasy; it may no longer be a ridicule to fancy the day when a tiny cell from any part of the body of a genius or a Nobel Laureate could be reared in test tube to obtain a duplicate of that individual. But what is it like today? Ape kidneys, pig livers and chimpanzee hearts have already kept human patients alive to varying periods of time; the modern biologist hopes that some day he would be able to raise such organs in aseptic media in his laboratory, the 'organ factory'!

Yet another aspect of research on sex is the rearing of multiple embryos in foster mothers. The cow, for example, contains thousands of incipient eggs, but normally only one egg is released at a time. Through the use of two sets of hormones and different foster mothers, the ovary can be induced to release ripe eggs in quantity; artificial insemination could then fertilize as many as 100 eggs. The developing centuplets

could be fostered inside a rabbit for two weeks and thereafter inside cows. Thus a whole herd of pedigree cattle can be transported with ease and economy across vast oceans and distant lands.

Some scientists argue that instead of sending people in spaceships to colonize planets, it would be more sensible to send up tiny embryos of man or cattle, pig or poultry, or of any desired organisms nursed inside small-sized foster mothers, under the care of a team of competent biologists who could rear the tiny embryos into adults in space. In fact, plant scientists are already studying the growth and development of plant tissues sent up in spaceships and exposed to the environment in space.

What will be the impact of all these biological thoughts and knowledge on our society? What will be the status and identity of the individual produced in test tubes? Answers to these and many other puzzling questions are disputable not only for the theologist, the philosopher, and the scientist but also for the common man. The common man is dazed at the thought of transformation which the scintillating experiments in biology can effect in our society. When sex is relegated to a secondary position in biological systems and consequently in human society, man will be forced to establish a new set of laws, ethical and sociological, for posterity. Some day biology itself may give us an insight into the nature of life, allowing us to formulate new ethics and sociology to be consistent with nature. For the triumph of intellectual right, it is necessary we keep "open to novelty and change and not close them down against progress" (Charles Morris).

N.S. RANGASWAM'
AKHILESH SHROTRI

Botany Depti

Univ. of Dell

The woman behind the DNA scene—Rosalind Franklin

M UCH has been said and written about deoxyribonucleic acid DNA) and its helical structure, but he honest worker who founded the basis of the helix has so far remained obscure. This brilliant scientist, Miss Rosalind Franklin, was the fictim of a double tragedy—not only he died in the prime of her youth 137, she was also deprived her of ourt of the credit for discovering he structure of the DNA molecule.

Miss Franklin, born in London n July 27, 1920, was the elder aughter of E.A. Franklin. She vas educated at St. Paul's School, ondon, and Newnham College, ambridge. After studying physical hemistry at Cambridge she started er scientific career. Her first mployment was in the British Coal Itilization Research Association where she worked on the colloidal roperties of cokes and chars. She howed that although the total olume of pores in coal increased ontinuously with increasing temperaure, their accessibility so decreased hat finally even helium molecules ere unable to penetrate them.

In 1947, she joined the Laboratoire entrale des Services Chimiques de Etat in Paris. Here she learnt he monochromatic X-ray technique f amorphous substances. ories of experiments she discovered he fundamental distinction between arbon that burnt into graphite on eating and which that did not. She irther related this difference to the hemical constitution of the original nolecules from which the chars were ade These studies are of fundamen-I interest today both to the coking idustry and to the industry of grahire moderators in atomic piles.

However, Miss Franklin was more

she joined the Biophysical Laboratory at King's College where she ventured to apply X-ray crystallography to the investigation of the structure of large molecules of biological importance, particularly the nucleic acids and viruses. She took X-ray photographs of DNA and showed that the structure of DNA molecule could be best accounted for by a double helix.

In 1953, she left King's College to join Bernal's Laboratory at Berkbeck College, London. Here she took up the direction of research on tobacco mosaic virus. With her improved techniques, she carried out its X-ray study and confined that the virus had spiral structure but of quite a different nature from that which existed in proteins and in DNA of bacterial viruses and higher organisms. She showed that the virus particle was not solid as had previously been thought but actually is a hollow tube; and further established the nature and position of RNA in the viral particle. It is sad that this promising young scientist was taken away from the scene of life on April 16, 1958 at a time when promising discoveries were expected of her.

As a scientist Miss Franklin was distinguished by extreme clarity and perfection in her work. At the same time she proved an admirable guide to a research team. Her excellent working ability was not given due recognition by her co-workers and the scientist in her rebelled against such a hierarchical setup. Beneath the outbursts of this struggling genius was a magnanimous woman, whose strength and wisdom of character were reflected in her horesty and austerity of life. Her sincerity to

work reached the zenith whe stricken with a fatal illness, sh continued to work right upto th end. She was often criticised for he simplicity, disliked for her outspoke nature but quietly admired (feared' for her ingenuity so much so the at one time Maurice Wilkins (wh worked at King's College and late shared the Nobel prize in 1962 wit Francis Crick and James Watso for solving the problem of DNA molecule), himself a novice in th X-ray techniques, wanted som expert assistance from Miss Frankli to speed up his work. Watson later re marked in The Double Helix (A wor in which James D. Watson tells of th events which led him in 1958 to th discovery of the structure of DNA and subsequently win the Nobe prize) "It also became apparent to us that Rosy's (Rosalind Franklin difficulties with Maurice (M. Wilkins and Randall (J.T. Randall) were connected with her understandable need for being equal to the people she worked with".

Franklin's contribution to the structure of DNA

The tale of DNA revolved round five people: Maurice Wilkins, Rosalind Franklin, Linus Pauling, Francis Crick and James Watson. Wilkins Crick and Watson shared the Nobel prize for this achievement in 1962, Linus Pauling was also honoured elsewhere, Franklin was the only one in the race who was left in oblivion.

The importance of Franklin's work was lost sight of partly because of her untimely death. Her contributions to the structure of DNA have been lucidly detailed (Nature, 1968) by her friend and closest scientific colleague A. Klug of the MRC Laboratory of Molecular Biology, Cambridge. As early as 1952, Miss Franklin had suggested a helical structure for the DNA molecule. She recognised its two states "Crystalline and Wet"

ave the technique of preparing and king their X-ray photographs. he discovered the B form and defined onditions for the transition of the vo forms. She interpreted ree-dimensional Patterson funcon. The use of 3-D data made it ossible to propose an orientation for ne helical molecule in the unit cell nd also the position of the phoshate groups along the helical chains, nus establishing the essential features f the DNA configuration. After ne formulation of the Watson-Crick nodel she demonstrated that a double elix was consistent with the X-ray attern of both the A and B forms. It is not the least surprising when ne studies her papers and notebooks nd realizes how close she herself had ome in the progress of her workbeit in disconnected fashion at ifferent times—to various features f the structure contained in the orrect solution", opined Klug.

and B in later terminology) and

Watson at one time admitted hat the X-ray pictures made by ranklin and Wilkins at King's follege, were shown to him and crick who were working on a

Bacterial flagella

model of DNA molecule which was going on badly until then. The Xray photographs showed that the DNA is a helix, not a simple but a double helix, and that the phosphoric residues are on the outside. The essential features of the DNA pattern were clear to them and "only minor modifications were necessary in our backbone configuration." few weeks later, Watson and Crick had the model completed and published their results (Nature, 1953).

Her friends and colleagues have paid glowing tributes to Franklin, but the finest that could come was from her one time rival Watson who confesse after her death: "We came to appreciate greatly her personal honesty and generosity realizing years too late the struggles that the intelligent woman faces to be accepted by a scientific world which often regards women as mere diversions from serious thinking."

> SNEH PRABHA MEHTA Publications & Information Directorate, CSIR, Hillside Road. New Delhi-110012

of bacteria, the spirochetes and myzobacteria, which are nonflagellated but still possess the property of gliding or creeping movement. It should also be noted that bacterial motility should not be confused with "Brownian movement". In the latter case, bacteria do not move but only vibrate due to the bombardment of bacterial cells by the molecules of the fluid.

Structure of flagella

Flagella of bacteria are structurally different from the cilia and flagella of animals and higher plants. Bacterial flagella are thin (width about 0.05µ and length 3-12µ), wavy, filamentous and helical appendages consisting of two or three tightly wound strands. They are too thin to be seen with an ordinary light microscope To reveal them with ordinary microscope, a special staining technique is employed using a mordant such as tannic acid which causes precipitation of the staining reagent forming a coating on the flagella and making them thicker The wavelength and amplitude of the helix are characteristic of the bacteria.

The number and arrangement of flagella on the bacterial surface vary considerably with different species Four different groups are generally recognized—a single flagellum at one end of the bacterial cell is called

flagella (singular-flagellum). This property of movement is, however,

TT is a pleasant pastime for a bacteriologist to see through his nicroscope and observe the minute reatures, the bacteria-moving in the ilm of liquid in their characteristic vay; some moving like snakes in a igzag way, others revolving like a ropeller while moving forward and ackward, and still others dashing traightway from one end of the nicroscopic field to the other. Bacerial motility is generally associated with the presence of very thin, slender and delicate appendages called

ngt possessed by all bacteria.

Depending upon this character, the bacteria are broadly divided into motile and non-motile bacteria. The coccoid bacteria, i.e., those having spherical or ovoid structures are mostly non-flagellated and so non-motile, while many of the rodshaped bacteria and most of the spiral bacteria possess flagella and are consequently motile. Mention may be made here of two other groups



Fig. 1. Bipolar tufts of flagella of Spirilla in a stained preparation

nonotrichous type as in Vibrio; a uft of flagella attached at one end is alled cephalotrichous as in Pseudononas, while tuft of flagella at both ands is called lophotrichous as in Spirillum; and flagella distributed wenly throughout the surface are alled peritrichous type, e.g., in Sacillus and Escherichia (Fig. 2).

Chemistry of flagella

Flagella differ in chemical nature from the bacterial body. About 98% of the total weight of flagella is composed of a protein called flagellin. The atter is a fibrous protein just like the nuscle protein, myosin. In some ases it has also been reported that surified flagella dissociate at mild wified flagella dissociate at mild w



lg. 3. A swimming bacterium of se species Spirillum

4 different amino acids thus pointing ut to a difference in the nature of agella and cell wall. The flagellar rotein is also considerably more esistant to tryptic digestion than the ytoplasm.

rigin

Some believe that flagella are mere attensions of the cell wall while others old that flagella originate from cyto-lasm. Two direct and convincing vidences indicate the cytoplasmic

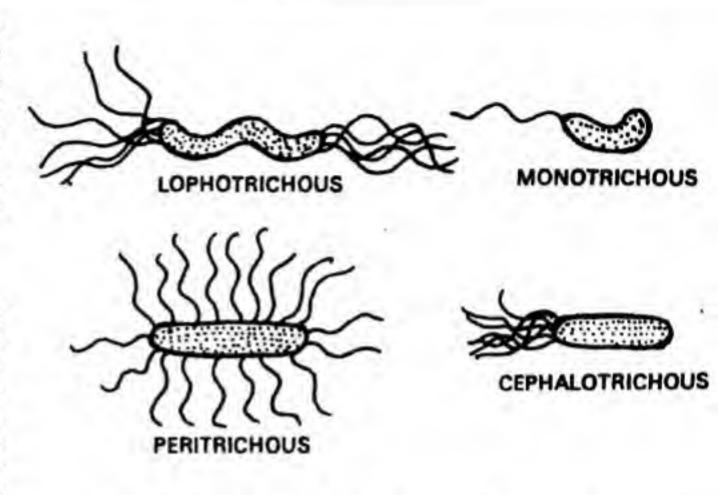


Fig. 2 Different types of flagellar arrangement in bacteria

origin of flagella. Electron micrographs have shown the flagella penetrating the cell wall and extending into the cytoplasm. Still other photographs have shown that flagella originate from minute cytoplasmic granules (0.1 to 0.25\mu in diameter) called basal granules. It has also been shown that when cell wall is dissolved with agents like lysozyme, typical flagella are still present attached to the cytoplasm. Also, the difference in chemical nature of flagella with cell wall favours its cytoplasmic origin.

How do flagella help in movement

Actually how locomotion in bacteria takes place is still a mystery. The metabolic source of energy for bacterial motility and conversion of chemical energy into mechanical energy by the flagella is still a vexatious question. Little exact knowledge has so far accumulated. It is believed that a mechanism similar to that in contraction of musle fibres takes place in bacterial flagella. It is a known fact that isolated muscle fibres can contract when supplied with ATP

(adenosine triphosphate), and during this contraction ATP breaks down into ADP (adenosine disphosphate and inorganic phosphate with simulataneous liberation of energy. similar mechanism operates during contraction of flagella. Though directly evidence is lacking, some indirectly evidences indicate that a stead supply of ATP is required for main tenance of flagellar movement.

It has been observed in moti species of bacteria that when ce wall is removed keeping the flagel intact, they loose power of motilit. This suggests that cell wall may have a direct role in motility of bacteria of acts as an auxilliary organ in flagella action.

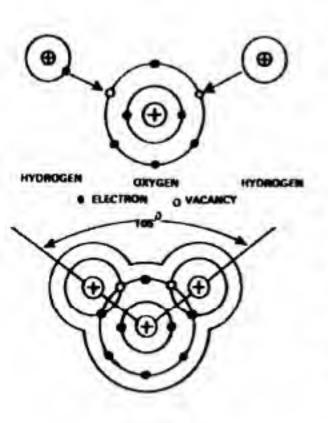
The speed of locomotion in bacteria is actually slower than it appear under the microscope, for the obvious reason that the microscope magnification apparent speed just as it magnificate size of the organism. The average speed of bacteria is generally not more than 10 cm per hour, though some species of Vibrio can attain speed as high as 20 cm per hour.

SUKUMAR CHATTERM

The hydrogen bond

THE simplest atom, hydrogen, has a single electron in its orbit. he spatial distribution of electrons n an atom is usually represented by rbitals and is expressed mathematially by wave function. The square f the electron wave function at a oint in the configuration space is roportional to the probability of nding the electron at that point. he conception of electron cloud ears a physical meaning. The elecron cloud in Is orbital is spherically ymmetrical about the central nuleus. Hydrogen, in nature, exists s diatomic molecule and the covaent bond is responsible for its diatonic nature. The overlap of the 1s rbitals of two H atoms forms a table covalent bond.

A covalent bond is made up of a hared electron pair and is sometimes eferred to as an electron-pair bond. Is the two H atoms in a H₁ molecule re identical, the electron pair is hared equally and the electron cloud is symmetrical. When a covalent ond is formed between unlike atoms, he electron charge becomes unsym-



Ple. 1

metric. In oxygen molecule, having six electrons in the outer shell, the valence bond may be in two ways: a double bond may be formed between two oxygen atoms; the oxygen molecule, like hydrogen, may be held together by a single covalent bond. Each molecule, therefore, has two electrons which are left unpaired. This accounts for the fact that O₂, whether in its solid or liquid or gaseous state, has the property of being attracted by a magnet—a property which is rare except among metals and metallic salts.

In HCl, Cl is more electronegative than hydrogen. The electron clouds are displaced more towards Cl, leaving the H atom with partial positive charge. This typical covalent bond is called a polar bond, as the molecules are dipole in nature. When the electronegativity difference is sufficiently large, electrons may be transferred completely from one atom to another, creating a pair of ions of opposite and equal charge. These ions form ionic bonds. An ionic bond is responsible for holding sodium and chlorine atoms together in sodium chloride.

Molecular structure vs extraordinary physical properties of water

When hydrogen and oxygen combine to form H₂O, the shape of the resulting orbital determines the distribution of positive and negative charges within the whole molecule. The resultant molecule H₂O is what is called a polar molecule because its positive and negative charges are not distributed evenly around the centre (Fig. 1).

This model of H₂O introduces a slight polarity in the molecule. The dielectric constant of water is 80. This large dielectric constant makes

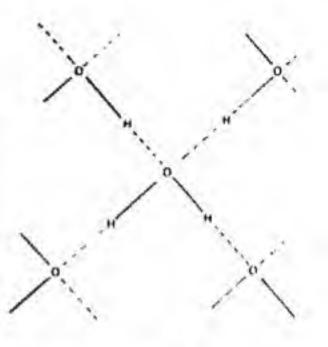


Fig. 2

water a universal chemical solven. When the weak ionic bond of NaC is broken by dissolving it in water the attraction between positive an negative ions is reduced by 1/80t as compared to vacuum. Therefore a permanent dissociation occur. But the dipole moment of a single molecule of water alone cannot explain the high solvent property of water.

The freezing and boiling points of a substance are related to its mole cular structure. It is reasonable expected that substances having similar structure should freeze of boil at the same temperature. Subtances having higher molecula weights require higher temperature for a change of phase. But, on th contrary, it is found that water ha higher boiling and freezing point than its functional isomers H.Te H₂Se and H₂S. An estimation of freezing and boiling points of water with the consideration of the orde of molecular weights of these nobl gases leads to the expectation of thes values to be about 173 K and 19 K respectively, but they are ver high.

There are many other peculiarities in the physical properties of water Water has a high heat capacity. It specific heat, that is, heat capacit per kilogram is 4185 J kg⁻¹K⁻¹. Water can store more heat energy with less atomic and molecular agitation. We put this property to practical uses— ice for refrigeration, use of water as coolant in thermal reactor, etc. The heat of vaporization of water is 2256. 10^a J kg⁻¹ which is highest among all known substances. Because of this property water acts as an effective mediator in the primary regulating mechanism to control the temperature of animals and plants.

The anomalous behaviour of water, however, requires a scientific explanaion. The two hydrogen atoms, sharng their electrons with the oxygen tom, completely expose their nuclei Fig. 1). Each of these exposed positive charges exerts an attractive orce upon any single or unpaired lectron-- and because oxygen atom appens to have two such unpaired lectrons, each water molecule is ble to form four hydrogen bonds. Vater shows a tetrahedral coordinaion around each oxygen atom Fig. 2). I'wo such water molecules join o form a complex, and the phenonenon is called molecular associaion. The dipole moment is now irtually doubled. Hence the ability f water to form H-bonds accounts or its unusually large dielectric consant, and this, in turn, increases its apacity as a solvent. As the moleule of water is a chain type, its pparent molecular weight is increaed. This in turn increases its freezig and boiling points.

lydrogen bond

The unusual properties of water

1 12. 1

CIS FORM INTRA MOLECULAR

Fig. 4

have been satisfactorily explained by the postulate of 'hydrogen bond'. There are several hydrogen-bonded systems like water. In general, hydrogen bond is formed when a hydrogen atom is bonded simultaneously with two electronegative atoms A and B instead of one. The one which donates hydrogen atom for H-bond formation is called a proton donor (A) and the other which receives the hydrogen atom is called a proton acceptor (B). For example, hydroxyl group ("OH) and amino group (NH₂) are proton donors and the lone pair of electron of an electronegative atom and a # electron orbital of a multiple bond system are the proton acceptors. Increase in the electronegativity of an atom enhances its capacity to form Hbond. The hydrogen bond is mainly electrostatic in nature as it is formed as a result of attraction of a covalently linked proton by the unshared eletrons of an atom of another molecule. In almost all H-bonds this proton is not equidistant from the two atoms linked to it, but is nearer to the atom with which it is covalently linked. In the case of water, O-H and O ... H distances are found to be 0.99 A and 1.76 A respectively by

neutron diffraction method. The potential energy curves for the hypothetical motion of a hydrogen atom along the bridge provide an ingeniou way to predict the exact position of the H atom.

H-bonding, in most cases, cause a decrease in the total number o free molecules and an increase in the average molecular weight leading to an increase in viscosity. Also the formation of an H-bond, A-H.. B leads to an increased polarity of the bond A-H and hence to a larger dielectric constant and a greater dipole moment. The energy of H-bond is small. It is of the order of 20x 103-40 × 105 J Mole-1, while energy of the covalent O=H bond is 40×10 J Mole-1. When the temperature is increased, the molecular complexes begin to strain themselves against the weak H-bond forces holding them. As soon as the strain is sufficient enough H-bonds are broken. When ice melts, about 15% of all the Hbonds are broken. About half of the H-bonds are broken at 313 K. Water vapours contain practically no H-bonds.

H-bonding is distinctly directional.

It can be taken to be approximately linear but an appreciable variation

the angle / A—H..B can occur. In uncertainty of about 20° exists the prediction of the orientation of the H-bond.

In general, H-bonds can be broadly assified into three distinct types. Intermolecular H-bonding (molecuir chain). It forms as a result of ttraction of a covalently linked roton by the unshared electron of an tom of another molecule. H-bondin water is an example of this pe. From womb to cemetery, our fe is based on water. The human ody is about 65 % water by weight, lood is 90 "; water and some tissues ich as brain, lung, kidney and iuscle contain about 80% water. ven our bones contain 22% water. he detailed studies of structure of ater offer a key to the understandig of the structure of biopolymers. Intermolecular H-bonding (cyclic imer). The H-bond in carboxylic cids does not break even when it is vaporated, which shows that the Honds in such cases are stronger. he oxygen atoms of carbonyl roups can form much stronger Honds leading to the formation of table double molecules of formic cid and acetic acid. Such a compx formation is called a dimer Fig. 3). The formation of cyclic imer is well established by electron iffraction methods.

Intramolecular H-bonding. It occurs then a proton donor and a proton cceptor on the same molecule re in a favourable spatial configuration. Typical molecules which exhibit intramolecular H-bonding are orthohalogen phenols, orthohydroxy etones and diols. Intramolecular H-bonding occurs only when the nolecules are in a cis-configuration. In a trans-configuration, only internolecular H-bonding can occur Fig. 4).

lethods of study

Spectroscopic methods. Infrared

and Raman spectra reveal the characteristic frequencies of molecular vibrations. Such frequencies are fixed by the masses of the vibrating atoms, the molecular geometry and the restoring forces holding atoms in their equilibrium positions in the molecule. Because of molecular interactions, frequencies of normal vibrational modes of a molecule are shifted to higher or lower values and the integrated intensity of the characteristic vibrational band is also modified. These spectral variations are mainly due to the result of interactions of the electron clouds of molecules which are in close proximity.

In general the integrated intensity is increased and the stretching mode and its harmonics are shifted to lower frequencies by H-bond formation. In many systems, the shift is 10% of normal mode of vibration. These spectral variations correlate very well with important chemical and physical properties of H-bonding systems. The correlation is based mainly on the fact that the formation of an H-bond restricts certain

rotational and translational degree of freedom and forms an equal number of new vibrational degrees of freedom.

Dielectric polarization method The structure of a molecule associa ted or non-associated can be we analysed from its dipole moment, an from which the excess of moment du to H-bonding can be determined The nature of H-bonding interact tions becomes more informative wit the knowledge of excess moment, a the dipole moments have direction ally additive properties. The fur damental quantity, which is deper dent on both polarizability -- the sur of orientation and distortion polar zations, and the dipole moment the dielectric constant. The dielectric tric constant of a substance can b determined by measuring the caps citance of a parallel plate condense with and without the substance pla ced in between them.

> M. MEYYAPPA Lecturer in Physic Govt. College, Kumbakonai (Tamil Nadi

Fluorocarbons are dangerous to atmosphere

Much attention has been focussed recently on the atmospheric pollution caused by the waste products released by engines of highaltitude planes. Nitrogen oxides and sulphur dioxide released by planes react with ozone in the stratosphere (11-30 km from the surface of the earth). They reduce the concentration of ozone, which is maintained by natural processes. Because any decrease in ozone level is bound to adversely affect mankind, plants and animals on our planet, various proposals have been put forward to regulate or even ban the flying of high-altitude planes. But it seems potentially far more dangerous pollutants are being released by use from the surface of the earth. The are the fluorocarbons such as CFCI (fluorocarbon-11) and CF₂CI (fluorocarbon-12) used extensivel (under various trade names) as refrigerants, solvents and propellant in aerosols. Fluorocarbons first came into use as refrigerants around 1930 because of their valuable properties, like non-inflammability, low toxicity and low chemical reactivity

Later on, when low pressure values were developed, fluorocarbons became the standard propellants for dispersing aerosols. Since 1955, their rate of production has increased progressively reaching a staggering figure of 1.7 billion pounds in 1973. The huge amounts of these products being used and released to atmosphere are probably causing an irreparable damage to the atmosphere. First scientific reports indicating significant reduction in ozone level due to release of fluorocarbons became known in June 1974 only. However, since then a number of scientific and other bodies have expressed concern. As a consequence a Federal Interagency Task Force on Inadvertent Modification of the Stratosphere (IMOS) was created by the US authorities in January 1975. After going through all aspects of the problem, the task force has issued a report in June 1975 confirming the gravity of the problem.

The stratosphere acts like a trap in our atmosphere where many chemically active constituents are present. They react with one another to maintain a delicate balance. The most important chemical present is ozone (O₂). It is formed in the stratosphere by a two-step process. First, a molecule of oxygen (O₂) is dissociated by ultraviolet (UV) radiation into oxygen atoms and then another oxygen molecule combines with an oxygen atom to form ozone.

The rate of formation of ozone is controlled by the incoming UV adiation. It is, therefore, independent of human control. Ozone is ontinuously destroyed in the

stratosphere by reactions:

The natural concentration of ozone is maintained by balancing of ozone-forming and ozone-destroying reactions.

The atmospheric layer of ozone surrounding us acts like a blanket, shielding us from the harmful UV radiation from the sun. UV radiation represents energy in the lowwavelength and high-energy part of the electromagnetic spectrum. This radiation, specially that in the range of 280nm-320nm called UV-B radiation by biologists, can cause damage to human, animal and plant systems. But, the intervening layer of ozone in the stratosphere continuously absorbs UV radiation giving off the absorbed energy in the form of heat. The mechanism of absorption of UV radiation and subsequent release of heat probably involves excited state of ozone molecule as the intermediate.

As mentioned earlier, C1 and NO radicals can destroy ozone, but fortunately their natural concentration in stratosphere is limited. The picture will change drastically if any man-made materials containing these groups were to reach the stratosphere. Most ordinary chemicals containing C1 and NO groups decompose in our immediate neighbourhood, troposphere (0 km-11 km from the surface of earth). The decomposition products get back to the surface of earth via rainfall or other means. On the contrary, fluorocarbons are capable of reaching stratosphere, being virtually inert in troposphere. Once they reach stratosphere, fluorocarbons are capable of absorbing

radiation and decomposes. The decomposition products include reactive CI and F atoms which can caus significant reduction in ozone-leve leaving us to the mercy of U radiation.

Biologists have found that exposur to UV-B radiation can cause ski cancer, sunburning and skin-aging i bumans. The radiations are absorb ed by cornea and lens in the ey photokeratitis an to cataracts. Since the radiation is no sensed by the visual receptors of th eye, the damage is caused without th individual knowing about it. Nuclei acids DNA and RNA absort strongly around 260 nm, hence the are the most sensitive sites for UV injury in plant and animal cells. The absorbed energy, if not lost as heat may be used in altering the chemica structure of the absorbing molecule Because of their importance in sto rage and transmission of genetic infor mation, any change in the chemica structures of nucleic acids, DNA and RNA, on increased UV absorption will have drastic results. Preliminary studies carried out on microorganisms indicate that both the irreversible and photoreversible types of injury are caused. Proteins are also susceptible to UV injury, because they absorb strongly around 280 nm. Other possible effects include changes in growth characteristics of certain food crops and change in the effectiveness of agricultural chemicals like pesticides. Finally, some scientists believe that change in ozone concentration in stratosphere may drastically change the weather elements like temperature, wind pattern and precipitation, etc.

> B. C. SHARMA P.I.D., New Delhi

Chromosomal aberration and associated diseases in man

T is a very common experience that a mango plant, when propaated either vegetatively or through eds, always produces a mango lant. A banyan never produces ny tree other than the banyan. he statement is true not only of lants but also of animals. These asic similarities between parents nd offsprings are said to be hereitary characters and the transmision of these characters from one eneration to the other is governed y structures known as chromosomes. hese chromosomes are microscopic. read-like structures consisting of NA and protein, a definite number f which occurs in the nucleus of nimal or plant cell. The great delity with which chromosomes ransmit the hereditary characters ake amply clear their role in deermining the actual build-up of an rganism. So it is natural that any eviation in chromosome number or tructure in an organism will lead structural and functional variaons in that organism.

Normal human beings contain 46 hromosomes arranged in 23 pairs, f which there are 22 pairs of nonsex bromosomes or autosomes. There a pair of sex chromosomes XX in ne female and XY in the male. foreover, on the basis of length nd some morphological similarities ne 22 pairs of autosomes are divied into 7 groups, designated as ,B,C,D,E,F, and G. Any deviation rom the normal chromosomal setp in any individual leads to clinially recognisable disorders. Many pes of chromosomal aberrations nd the associated disorders have een described in human beings.

Chromosomal trisomy and monosomy

Chromosomal trisomy is a case where there is one extra chromosome so that the total number of chromosomes becomes 47. In case of monosomy, however, one chromosome of a particular pair is absent making a total of 45 chromosomes only. The best known clinical condition caused by chromosomal trisomy is called Down's syndrome or mongolism. In these persons, there are three chromosomes of the No. 21 autosomes. Persons with this defect are stunted in growth, have characteristic slanting eyes, stubby hands and a very poor mental development. The incidence of trisomy 21 is about 1 in 600. Advancement of mother's age increases the chance of mongoloid births. Trisomy of other autosomes are also knownone in the 17-18 autosomes and the other in the 13-15 group. Individuals with these conditions usually die in infancy.

Trisomy of sex chromosomes produces persons with clinical symptoms known as Klinefelter's syndrome and have a chromosome complement of either XXY or XYY (in addition to the 44 autosomes). Persons with XXY complement occur in one of 500 live births. They appear as males but are sterile and a tendency towards femaleness can be recognized. Men with XYY abnormality are characterised by a very tall physical height, extreme aggressiveness and criminal attitude. Trisomy of the X chromosome also occurs and such females (44 autosomes plus three X chromosomes) are found in the proportion of about one per 1000. They are normal in growth, fertile but ar mentally defective.

If a germ cell (sperm or ovum lacking a chromosome unites with a normal germ cell, the resulting individual will have 45 chromosome and the condition is known as mono somy. A complement of 44 auto somes and one X chromosome give rise to a female with an abnormality called Turner's syndrome. This ab normality occurs in the ratio of in 5000. The symptoms include incomplete or faulty development o the ovaries, short stature, low-se ears, webbed neck, and shield-like chest. Persons monosomic for a autosome are not known, that is when an autosome is missing the ferti lized ovum apparently does no survive. Similarly, loss of an 2 chromosome resulting in 44 auto somes and one Y chromosome i also fatal.

The cause of these anomalies is chromosome number lies in th faulty cell division during formation of sperm or egg cells. In this defect known as "meiotic nondisjunction" a pair of chromosomes fails to se parate during the reduction division (meiosis) in the formation of th germ cells. One germ cell contain both of a pair of chromosome while the other cell lacks that chro mosome. Normal germ cells con tain half the number of total 4 chromosomes, i.e., 22 autosomes and one sex chromosome. As a resul of faulty reduction division, som germ cells contain 24 chromosome and the other will have 22 chromo somes. When such abnormal gern cells take part in the formation of the foetus there occurs aberration of chromosome number in the re sulting individual.

Chromosomal translocation and deletion

In translocation broken par of a chromosome gets attache o another, resulting in abnornality. The best known translocaion is found in a type of Down's yndrome. In deletion, a part of a hromosome gets lost. The loss of segment of chromosome in the -5 group causes a syndrome known is the 'cri-du-chat' characterized by cat-like cry of the child. The inant is physically and mentally rearded and dies in childhood.

hromosomal mosaic

Persons with this type of aberraion have at least two different types
of cells with respect to chromosome
number. Mosaics appear due to
ailure of chromosomal separation
luring the first cell division after fertiization. As a result half of the
ndividual's cells are trisomic and
alf are monosomic for that partiular chromosome. With advancenent of age the proportion of cells
epresenting the two cell lines would
ary in different tissues. Mosaic-

ism may also result from loss of a chromosome. The effect of chromosomal mosaicism varies from mild to severe defects in the actual build-up of the organism.

In addition to the above disorders, many other diseases of man are known to occur due to defects in the hereditary material. Disorders like alkaptonuria, phenylketonuria, cretinism, albinism, galactosaemia, sickle-cell anaemia, thalassaemia and many others may be mentioned as examples. But as these diseases are due to defects in the structure of deoxyribonucleic acid (DNA) of chromosomes and do not involve gross chromosomal aberrations like anomaly of chromosome number or structure, they merit a separate discussion.

Department of Microbiology

Bose Institute

Calcutta 700009

maharajas or local villagers.

It is reported that in Tamil Nada a viable population occurs in the Point Calimere sanctuary but the is rapidly being poached out. If you have been introduced in the Guindy Deer Park. The author has heard of the presence of the black buck around the Lower Bhavani dam in Coimbatore district and has seen a few in the Vallanad Hills, Tirunelveli district.

The black bucks are medum-size slender antelopes. The bucks stand 73 cm to 83 cm high at the shoulde and their total length is 120 cm to 145 cm. The weight of the buck varies between 30 kg and 40 kg while that of the does between 30 kg and 38 kg.

In adult bucks, the back, side and the neck part of the face an outside of the legs are black. Th chest, the abdomen, the rump an the inside of the legs and tail as white. A white ring surrounds eac eye and there are patches of whit on the nose and chin. The nap is rusty. The does and fawns ar light brown in those parts of th body where adult bucks are black and white in the remaining portion Adult bucks seem to undergo a conspicuous change of pelage colou during a molt. Horns are marke with rings and make three to fou complete spirals in adults. The re cord horn length is 72 cm. In th yearling buck horns are withou spiral. In the second year a larg open spiral is developed. It is belie ved that the full number of spire twists is attained with the dark coa about the end of the third year Horned females are rarely met with

The black buck ruts throughout the year with two active breeding periods. The gestation lasts nearly six months and the active breeding periods fall in March—April and August—October months. Owing to this, the birth of the fawns coin

Black buck—India's beautiful antelope

THE black buck (Antilope cervi-L capra) is the sole representative f the Antilope and is typically Indian n distribution. When the species oamed in herds about the open coodlands and cultivated tracts of ndia, it formed the staple food of he extinct Indian cheetah. These uge herds, which formed an easy arget of the hunters, are now gone. he remaining black bucks are only few in number and they cling to ne last vestiges of their former anges in small scattered groups. ome authorities recognize four subpecies of the black buck. Of this ntilope cervicapra centralis occurs central India, Antilope Cervicapra ajputamee in Rajasthan and Punjab, ntilope Cervicapra rupricapra in

Uttar Pradesh eastward, and Antilope Cervicapra in Southern India. The states of Assam, West Bengal and Kerala are said to have no black buck. In Orissa, the species is confined to about 190 sq. km of sand dunes on a spit of land that separates Chilka lake from the sea. The species is on the verge of extinction in Uttar Pradesh and almost extinct in Bihar. In Mysore, Maharashtra, Punjab and Gujarat the black buck population lives in scattered groups. In Madhya Pradesh, a few black bucks are found in Kanha Park and Shivapuri Park. A stronghold of the black buck in India appears to be Western Rajasthan where it is found sporadically in the isolated semidesert parts protected in the past by

des with the North East and the outh West monsoons respectively. In the during the rains enables the wn to get maximum cover and rod. Usually only one fawn is born a time. At times twins are born and the author has seen a doe with the fawns in the Vallanadu Hills.

In areas where they are not disrbed, they are diurnal and are
spable of remaining in open areas
robably tolerating direct sunlight
such more readily than other wild
rigulates. But in disturbed areas
ke Vallanadu Hills, they come out
the cover mainly after dark and
streat soon after the dawn. Black
sucks are mostly grazers. These anirals can withstand long periods
ithout water and may have a meranism to derive metabolic water,
milar to that found in herbivores
hich inhabit deserts.

The black bucks appear to have good sense of smell and sight. ocalization is poorly developed. Then a black buck suspects danger, stands erect with head held vertically, and its forelegs may be stamping on the ground. In flight, they are a peculiar means of progression alled stotting or spronking. While pronking the animal bounds along tiff legged hitting the ground with all four feet in unison.

One of the visual and olfactory igns used by the bucks to mark heir territory is the deposit of their aeces at a specific location. A uck, defecating at a dung pile, sniffs he pile and paws once or twice with fore leg. Then it stands with his orequarters stiff and erect, the head aised and the horns lying almost parallel to the neck. The hind legs re stretched far back. He urinates n this manner, then squats low and efecates. This type of behaviour s not prominently exhibited by the oucks while defecating at other places. Another way to mark the erritory is by scent. For this, the



prominent preorbital glands are used to mark grasses and bushes with scent.

The leadership of a herd is usually vested in an old and vigilant female. Dominance among bucks is most commonly asserted with the head-up display. During this behavioural display the buck raises his muzzle so high that the horns lie almost alongside the neck. The ears are folded back, lowered and held somewhat laterally exposing the white surface inside. The stubby tail is raised and curved up over the back making the white patch on the rump conspicuous. With the preorbital glands everted, the buck approaches his opponent at a prancing walk. Sometimes the head may be bobbled up and down, flashing the white chin. Occasionally, the buck bounds forward in a stiff-legged gallop, uttering a series of harsh grunts and jerking up his head with each sound. The threatened buck usually turns aside. A direct threat consists of lowering the head until the muzzle almost touches the ground and tip of the horns is pointed at the opponent. The posture may be intimated by a rapid downward jerk of the head, a gesture usually sufficient to cause the other animal to retreat.

During courtship the buck sniffs the anal area or the fresh urine of a

doe. With curled lip, preorbital glands everted and muzzle raised in a typical head-up display, the buck prances with short steps after the doe. Harsh grunts may be emitted while chasing the doe. The buck shows his intention to mount by placing his chin on her rump, a gesture which causes her to stand still if fully receptive or to walk or trot ahead if not. A few days before parturition the doe withdraws from the breeding herd and has her young in a secluded spot. The doe, after giving birth to the fawn, may spend nearly a week in the vicinity of the young often visiting to suckle. During this period the young fawn spends much of the day lying quietly in a patch of grass or thic kets. It joins the herd with the mother after a week or so.

The black bucks are one of the fastest running mammals of the world. Their speed could have saved them in the past from the cheetah, the hounds, the jackal and the men on horse back. But now against the modern man, with his jeeps and fire arms, the black buck have little chance of survival.

A.J.T. JOHNSING
Asstt. Prof. of Zoolog
Ayya Nadar Janaki Ammal Colleg
Sivakasi (T.N



NEWS & NOTES

Is there a real menopause for males?

TOT every man experiences a midage crisis, but the phenomenon eems to be fairly common. A anadian study revealed that "good amily providers", aggressive and ard-working men, often experience he mid-life crisis. They seem to fear he loss of ability to work and are hreatened by younger men encroahing on their turf. Executives on he upper rung are also extremely usceptible, when they suddenly beome aware that life should offer nore than work and money. Somemes a husbands' mid-life crisis may arallel his wifes' physical and emoonal changes, the husband tries to how he is "sicker than she". ometimes physical problems bring n the male mid-age crisis. They nay simply be physical signs that he "not as young as he used to be". lis hearing and vision are not as harp as they once were; he is slowng down. Looking at these signs, man may be depressed by the fact hat his life is at least half over. A nan may wake up to the fact that e has not achieved the goals in life e had set earlier. He may feel he as gone as far as he can on the ecoomic ladder. He broods over mised chances and may have a morbid ear of being fired A mid-life cris can be triggered by a death in e family, loss of job and chronic lness. For example, one man's crisis egan when his wife decided to go

back to work after their youngest child left home. With income of her own as a nurse, she was more independent and her husbands' ego was undermined even though he had no objections to her working.

The big question about male midlife crisis is, what will the outcome be? For most men, the problem is temporary and mild, as menopause is for most women. But it can result in risk taking either strenuous physical activities or financial gambles in the stock market, says psychiatrist Herbert Klemme of the Menninger Foundation. Some men during midlife crisis experience panic, depression, temporary impotence, or bealcoholics. Doubting his sexual adequacy, the man may seek to boost his ego with extra-marital affairs.

Good things can also come out the mid-life crisis. After askin "where do I go from here?", a ma may reorganize his career, person lity, and family life around new of jectives. Some men resolve to tal better care of their body or kick th smoking habit, or start exercising regularly. The best way out of the male mid-life crisis is for a man t accept the fact that he is growin older. He needs to give up unrea listic goals and realize that he st possess much untapped potentia to draw on the rest of his life Men in their 40's and 50's ca take heart in the fact that the friends of the same age are probable undergoing a similar experienceeven if they are not talking about i

R. RAGHUNATHA

Nobel biologist Monod passes away

DR. Jacques Lucien Monod,
Director of Pasteur Institute in
Paris and the Nobel Prize-winning
French biologist, died recently in
his home at Cannes at the age of 66
years. He shared the 1965 Nobel
Prize for Medicine or Physiology
with two colleagues at the Pasteur
Institute, Francois Jacob and Andre
Lwoff, for research on the mechanisms of biochemical reactions in
the living cell.

Born on February 9, 1910 in Paris, young Monod received his Ph.D. degree from the University of Paris and remained there till 1945. He then joined the Pasteur Institute as a zoology instructor. He was named head of the Institute's department of cellular biochemistry in 1954 and director in 1971. He was a professor on the faculty of science at the University of Paris from 1959 to

1967 and a professor of molecular biology at the College de France from 1967 to 1972. He was Rockefeller Foundation fellow in 1936 and a nonresident fellow of the Salk Institute in 1968. He was hero of the French Resistance. Held both the Croix de Guerre and the American Bronze Star.

With Dr. Jacob, Dr. Monostudied the mechanism of regulation of protein synthesis in the living cell demonstrating how one type of gen in its nuclei holds the template for proteins (to be synthesized) while another gene regulates the rate of synthesis based on whether a given protein is in short supply or it abundance.

R.K. DATTA Beth Israel Medical Cente New York, N.Y. 1000.



Zinc —its importance to human health

years been considered neurotic.
ome could not taste or smell; others
ad grossly distorted taste and smell
ensations. Yet nothing physically
rong could be found. Today they
re free of their problems as a result
is simple treatment with a metal,
inc. And that same metal treatment lately has been making other
medical notes—as a help for some
hildren with poor appetites and
rowth rates, for babies with a lifemeatening illness, for some men
with prostate disorders, etc.

Zinc is one of a class of substances resent in the body in only smallest mounts and is little understood, as vere vitamins 75 years ago. lodine one of these trace elements; copper, nd chromium are some others. Their otal weight in the body is only about 0-30 grams or less, but they are ssential. Without Iodine, the thyoid gland could not produce thyroid ormones and we would become retins—mentally retarded, physically inderdeveloped. Yet the ody contains only about 30 millirams of iodine. Only recently has t become apparent that zinc is rital, that lack of it can produce nany health problems and that zinc eficiency is not uncommon.

Speeds up healing of wounds

Much of the pioneering U.S. research on zinc centered on its role in wound healing. About 10 years ago, Dr. W.I. Pories made a key observation while studying wound-healing in laboratory animals and how it might be influenced by adding various compounds to their diets. One compound accelerated healing, and the effect was traced to its zinc content, which definitely sped healing. Dr. Pories and his coworkers then studied otherwise healthy young airmen recovering from surgery. All received the same treatment, but half also received zinc in the form of zinc sulfate. In the zinc-treated, healing time was cut almost to half. Another striking development came several years later with the discovery of the value of zinc in taste and smell disorders.

Names of disorders

They named the disorders idiopathic hypogeusia with dysgeusia, hyposmia and dyosmia. Translated, it means that the cause is unknown (idiopathic), taste acuity is diminished (hypogeusia), tastes are distorted and even revolting (dysgeusia), smell acuity is diminished (hyposomia), and odours are obnoxious (dysomia).

Common trait

Yet it turned out that the patients had one thing in common: low blood levels of zinc and they responded to treatment with zinc sulfate. Meanwhile evidence was accumulating that zinc deficiency could cause retarded growth. In the Middle East, where many people exist on zinc deficient diets, researchers for the first time found that many dwarf-like young boys gained height once they were put on a high zinc diet. Dr. H.A. Ronagy of Iran reported the results of a study of 187 dwarfs among 20 year old men, all having low concentration of zinc in blood and hair. Given zinc, they not only grew in height but also developed sexually.

Bables grow and become well

Recently, in 1974, another finding has been reported in England that could save the lives of many babies. Diaper rash is usually a passing irritation, but in some infants it thickens, spreads from buttocks to legs, face, and elsewhere. Diarrhoea also develops along with weight and hair loss. Such infants have a metabolic disorder, known as acrodermatitis enteropathica, that usually manifests itself at weaning and can be life-threatening. In such babies, Dr. E.J. Moynhan discovered gross zinc deficiency, and he has put a group of them on zinc sulfate. All the reports are now completely symptom-free and are thriving on zinc supplement alone. More recently, Dr. C.C. Pfeiffer has noted that many children, teenagers and some adults, have white spots in the finger-nails (and in some cases, in the toenails as well), apparently as a result of zinc deficiency. The spots could be looked upon as one possible warn-Treatment with zinc ing sign. along with vitamin B., Dr. Pfeiffer reports, clears smaller white spots and prevents further spot formation.

Prostrate disorders and sexual development

Dr. I.M. Bush has related zing deficiency to some prostrate gland disorders in men. Actually, while zinc is present in all body tissues the prostrate gland apparently has particular need for relatively large amounts and normally has the highest concentrations. Could lov concentrations cause trouble? Using zinc sulfate in doses of 50 to 150 milligrams a day for upto 16 weeks Dr. Bush has reported relieving urinary frequency, irritation and other symptoms of chronic abacterial pros tatis (nonbacterial inflammation of the gland) in 70 per cent of more than 200 patients he treated. When h tried the same treatment in a grou of men with benign prostratic hyper trophy, a common overgrowth of the gland which interferes with no mal urinary function, almost three of every four responded with reduction in prostate size. This may not include all conditions in which zinc could be important.

Role in building body proteins

Today some 20 essential zinccontaining body enzymes have been dentified. Zinc is known to be equired for building body proteins, enerating body energy, growth, exual development, taste and smell. The effects of zinc deficiency are still only partially known.

Zinc is present in most protein cods—milk, fish, meat and eggs. Whole grains also contain zinc. Although only 20 to 30 per cent of

total zinc in food is available for absorption and use by the body, a good diet provides 10 to 15 milligrams of zinc daily, which should allow absorption of 1 to 2 milligrams/day, an adequate amount. Some experts believe that zinc deficiency is far from rare in many countries. Dr. R.W. Luecke has noted that "there is ample reason to suspect that intakes of a number of individuals may be only marginal. Zinc shortages can be found in all people, rich or poor. Perhaps some people might benefit by taking a "Zinc pill" to supplement their diet."

R. RAGHUNATHAN

Harmful effects of VCM on fetus

JINYL chloride monomer V (VCM) is the basic chemlarge number of cal of lastics known polyvinyl 85 hloride (PVC). VCM has been nked to about 30 deaths around the vorld from angiosarcoma, a rare orm of liver cancer. The victims n most cases worked in the plants hat make VCM gas. The U.S. overnment is taking steps to reduce vorkers' occupational exposure to CM and has already banned its se in aerosol sprays. Recently, the J.S. National Institute for Occupaional Safety and Health, the U.S. Center for Disease Control's bureau f epidemiology and the University f North Carolina School of Public lealth studied the fetal death rates or women whose husbands worked t VCM plants and compared with ates among women whose husbands orked in rubber and PVC fabricaon plants, that convert the solid

plastic into consumer goods. According to their findings, before their husbands were exposed to the VCM, wives of men working in such plants had a fetal death rate of 6.1 per 100 pregnancies, below the 6.9 rate experienced by women whose husbands worked in the relatively safe rubber and PVC plants. But after their husbands were exposed to VCM gas, the fetal death rate for the wives of VCM workers went up to 15.8 per 100, as compared to 8.8 for the control group. The study suggested that the higher fetal death rate was caused by sperm cell damage in the father through direct VCM exposure.

These findings have raised serious scientific and public health concern for the possible genetic risks of VCM to humans.

BHAKTI DATTA

SIDS, the killer o

SUDDEN infant death syndrom (SIDS), more commonly known as "crib death" disease, takes the lives of thousands of babies—most between the ages of three weeks an seven months—throughout the world Death due to SIDS is more during winter months and is common with children having a series of mind colds. Prematurely born infant are more prone to the disorder, a are those from the lower strata of society.

The greatest after-effect of SID is the guilt that parents invariable feel after the death of the child Though the guilt is slowly ove come, for many parents the burde of guilt persists. There is no proc that suffocation is the only caus of SIDS, as many victims have bee found lying dead with their face completely uncovered. A bizzar allergic reaction to cows milk, as th cause for SIDS, has also bee disproved, since many of the babic been entirely breast-fee Presently only this much is know that SIDS strikes without warning and cannot be predicted of prevented.

Fortunately, a substantial amour of money is being spent on SID research to understand the syndrom in greater detail. Though no clea cut answers are available, man clues have come out of the extensiv research. During a study of 97 SID victims, 93 had abnormally low leve of the enzyme required to maintai an adequate amount of sugar in bloo at night. This finding concurs wit the observation that most of the cri deaths occur at the age when a bab begins sleeping through night with out feeding, and so would be mor likely to sufer a drop in blood sugar

(Continued on page 576



The strange world of viruses

YOU have read about the monstrous animals—dinosaur, brontoaur and diplodocaus—who tread the arth in the distant past and needed ons of food everyday to fill up their ellies. Today, they have all vanihed and their place has been taken by elephants and crocodiles who are mong the largest animals existing ow.

But have you ever wondered what on the lowest side of the scale? hat is, what are the smallest living nings in the world? Until the last entury, insects were taken as the nallest creatures of the world. ven so, scientists had suspected that nere were organisms which were such maller than the smallest insects and nat they were really causing the soalled infectious diseases. The invenention of microscope helped them lentify those smaller organisms, ow known as bacteria, protozoa nd other microbes. It was soon ealised that there were also living ells even smaller than bacteria.

Louis Pasteur (1822-1895) in the ast century was experimenting with ovine Pleuropneumonia (infection the lungs of cattle) and found that he agent causing the disease was so mall that it could not be seen through the microscopes then in use to observe bacteria. In 1892 Russian

scientist D. Iwanosky, while making experiments with mosaic diseases of tobacco plants, found that the agents causing the disease could pass through filters used to trap bacteria.

The elusive organisms

What were then these organisms which were determinedly eluding detection by the microscopes? Interest in them was gradually rising because of their possible association with some of the ravaging diseases of men, plants and animals. Were they living or dead cells? Were they something invisible, something beyond the reach of optical eyes? Scientists could not give definite answers to these questions although they admitted the existence of these mysterious organisms which were causing immense loss of human, animal and plant life all over the world. In effect, these organisms appeared to dodge all efforts at detecting them.

Around 1930 the scientific world saw a special powerful microscope, called the electron microscope, which could reach magnifications as high as 1,00,000 and detect objects as small as a thousandth of micron (itself a thousandth of a millimeter) in diameter. Then, for the first time, man could see the strange and

the wonderful world of the sul bacterial organisms called viruses.

Viruses: their destructive power

Viruses have come to occupy th centre of interest perhaps main because they happen to be one of the deadliest enemies of all the livin things in the world. With equa virulence they scourge human animals, plants and even bacteria They are responsible for four of greatest scourges of human disease known so far, viz., 'flue', 'polio 'pox' and yellow fever. The great influenza endemic of 1918-19 too a toll of nearly one crore peop all over the world! More recently i 1957-58, we may recall the outbrea of the much dreaded Asian flu which killed thousands of persons in seve ral countries of South East Asia an also spread to other parts of th world. It is estimated that as man as 2 lakh persons in India alone d of smallpox every year and 5 lakh become disabled due to it. Police which maims hundreds of thousand of persons every 'year all over th world, and yellow fever, that 'horrible disease' in Africa, well epitomise th enormous annihilative power posses sed by viruses. Some scientists be lieve that cancer, another dreadfu disease of man, is also caused b viruses.

In the world of plants and animals viruses cause enormous loss of crop and animals almost in every countr of the world. Mosaic diseases of tobacco, potato, tomato and other crops are caused by virus. The pain ful foot and mouth disease of ani mals, animal pox and mumps ar also caused by virus. In India alon tobacco worth Rs. 2 crores an potato worth Rs. 6 crores ar destroyed every year by mosai diseases. In fact, so enormous i the loss of crops, animals and huma life due to viruses that it is almost impossible to express it in term of money.

Are viruses dead or living objects

The knowledge about viruses ha

owing to two reasons. First, they are too small to be detected in a cell or to be seen in an optical microscope. Secondly, they can reproduce only in the cells of their hosts They are completely stripped of metabolic machinery. For several years in the past, scientists were unable to any whether viruses were living or dead particles. Their ability to multiply in the cells of their hosts and transmit diseases to the hosts indeed suggested that they were alive.

A major breakthrough in the nystery of viruses was achieved in 1935 by an American scientist, Wendell Stanley, who obtained viruses n crystalline form! This came about when he was experimenting with the nosaic viruses of tobacco. He took he tobacco leaves heavily infected with mosaic diseases, mashed them up and tried to separate the virus by pplying the protein separation techinque. The result was that he obained mosaic virus in crystallised orm and the crystallised viruses when redissolved in the liquid were is infectious as before.

The fact that viruses could be crystallised led some scientists to believe that they were only dead proteins. No living thing had then been crystallised! Can life which was flexible and dynamic be turned into a crystal that was rigid and tatic?

This belief however was soon haken and the old suspicion about iruses being alive was revived when ome British scientists proved that II viruses were nucleic proteins ontaining Ribonucleic acid (RNA) or Deoxyribonucleic acid (DNA) or both. The difference between redinary proteins and the nucleic roteins is like the difference between the dead and the living. Nucleic proteins are the stuff genes are nade of; and since genes are the cry basis of life, viruses could not

be other than living substances.

It thus emerged out that viruses were similar to genes in chemistry and were as much alive as elephants and human beings.

How viruses enter host cells

Viruses can reproduce themselves only in the living cells of their host. Their manner of raid is rather interesting. The cell of a virus consists of proteins and acts as a means of breaching the cell walls of the host. The nucleic acid (RNA or DNA) present in the virus cell enters the host cell, taking over its chemistry and using it in its own interest. Very often, the cell of the entire host organism dies as a result of this invasion.

The process of virus reproduction in the host cell also explains why antibiotics, the modern 'wonder' drugs, have not been able to jam the virul machinery. Since viruses have no metabolic machinery of their own and depend entirely on materials of the cells they invade, it is difficult to destroy them without destroying the host cell itself.

Methods to visualise viruses

Most viruses measure between 10 to 200 millimicrons, that is, they are even smaller than the wavelength of light. Since objects smaller than the wavelength of light cannot be seen in an optical microscope, viruses escaped detection for a pretty long time. Now two methods, one direct and the other indirect, are employed to observe viruses. The method is the use of electron microscope. Usually electrons have wavelength much smaller than the size of viruses and when beamed at the viruses make them visible. Viruses are observed indirectly by preparing their crystals and obtaining their shadow under an X-ray. In the electron microscope their images

in X-ray defraction they can be observed in three dimensions.

Different shapes of viruses

Next to their peculiar mode of reproduction and destructive power the most interesting fact about viruses is their fascinating shape, size and symmetry.

Viruses have been seen in a wide variety of shapes and symmetry. For instance, pox virus appears like a barrel. The tobacco mossaic virus appears like a thin rod. The smalest viruses, those of polio and yellow fever, are like spheres ranging in diameter from 0.25 down to 0.2 microns.

Even more interesting than the shape is the fact that viruses have been found to possess an extremely high degree of structural symmetry. They form themselves into various types of geometric pattern. Such symmetries are found mostly in smaller viruses. In large viruses, geometry is usually more complex.

The polyoma virus suspected to be one of the viruses responsible fo human cancer has 42 faces, arranged in icosahedral symmetry. Turniy mosaic virus which causes diseas of leaves in the turnips has 32 face arranged in cubic symmetry. Ano ther group of viruses to which tobacco, mosaic, influenza and mumps viruses belong have helica symmetry. Until recently, helica symmetry was thought to be peculia to plant virus only, but now some animal virus (mumps, foul plague etc.) have also shown helical pattern

Recent studies in the symmetry of viruses have opened a new area of interest and have revealed that, ever though viruses cause disorder in other living things, they themselves lead a strictly mathematically ordered existence.

S.P.A.

Problem solving with computer

THERE is a strong tendency nowadays to attempt a computer olution to every problem, mathemacal or otherwise. This philosophy based on the fact that computers re essentially logical machines; so ney must be capable of solving man's roblems. Looking at the diverse pplications to which computers are eing used at present, the above hilosophy seems to be not far from e truth. The whole mystery lies the fact that logical situations in be translated into mathematical tuations. Once a problem is matheaticized, it is only a dog's meat to ne modern computer.

The basic steps involved in problem olving with computers are: analysg, dissecting, digitising, algorithising, coding, debugging, and obining a reasonable solution. Any omplex problem must be a combiation of several simple operations r procedures. A clear analysis will nable us to split the problem into s constituent simple procedures, hen every simple procedure is conerted into a mathematical model ivolving only the four basic opeations of addition, subtraction, nultiplication and division, which omputer can do. In fact, the mahine can do only addition. Howeer, because of binary algebra, the ifferent operations of subtraction, nultiplication and division can be educed to simple addition operaons only, and, therefore, these perations can be carried out by omputer. This process is called igitising. The various procedures re then written down in a logical nanner; this process is called algorihmising. Algorithmising is nothing out arranging the various elementary teps in a logical sequence for feed-

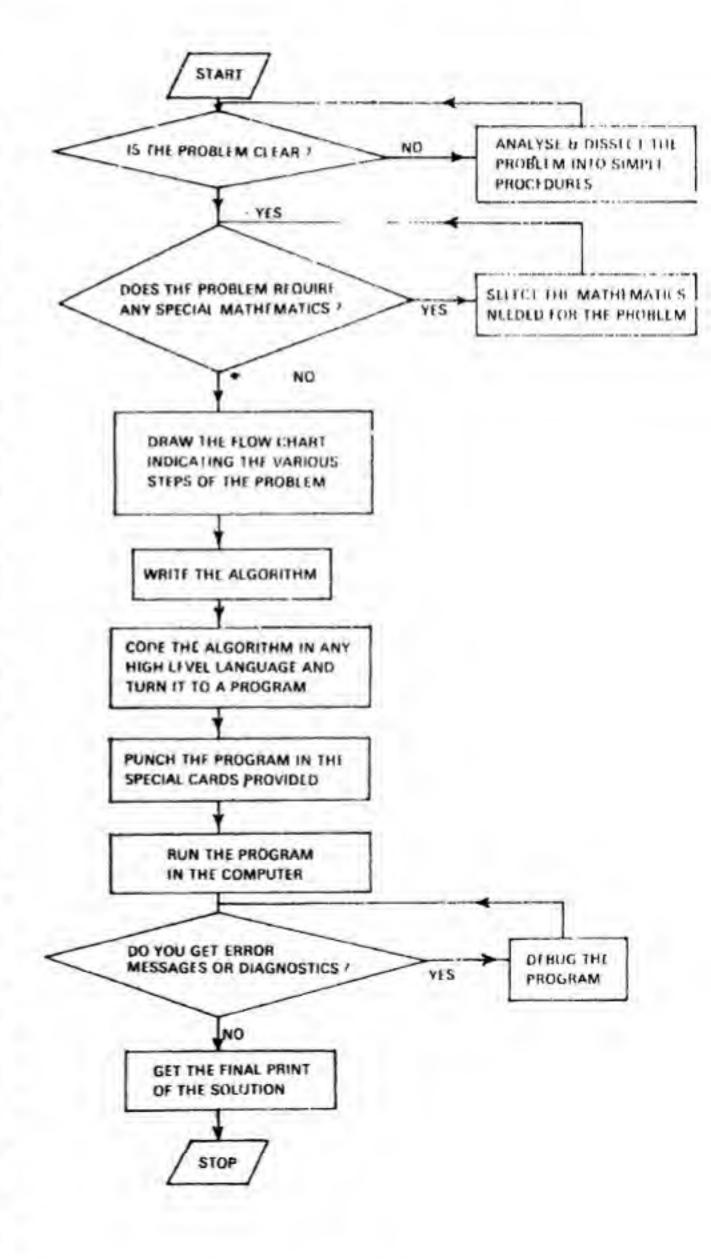


Fig. 1

ing into the computer. For a clear understanding, the algorithms are pictorially represented by means of flow charts. Once a problem is expressed in an alogrithmic manner, it can be coded into any of the high level languages, say, Algol, Fortran, Cobol or PL/I, and turned into a program. The program is then punched in the special cards provided for them and fed into the computer. Error messages or diagnostics are carefully watched, and the program

is suitably debugged until a reasonable solution comes out. The process involved in attempting a computer solution to a problem is illustrated by the flow chart shown in the figure 1. If the readers have a problem it can very well be attempted in the same manner.

R. RAMASWAMY

Asstt. Prof. of Physics

Thiagarajar College of Engg.

Madurai-625015

Ages, the length of a rod was determined by lining up 16 men outside of church on a Sunday morning. The combined length of all the left feet was taken as one rod.

Dollar

The first United States dollar was in the form of a silver coin. It was minted in 1794, and was calle "pillar dollar" as it had two pilla embossed on it with a ribbon twine around them. This is the origin of the dollar sign—\$.

Shoe size

The size of a shoe is measure from the ankle of the foot to its too For a shoe of size eight, the lengt measured from the arch of the foot to the toe is 8 inches.

The pulse-beat

To feel the pulse of a patient, doctor never uses his thumb, because it itself has a strong pulse beat.

Funny indeed

An old Chinese unit of weight for rice is catty. There is a very funnthing about this unit: it grows smaller as the rice is carried from field to port. As a coolie carries the rice bags to market, he takes out his charges in the form of rice. So the rice bags that reach the market weigh less than they originally weigh at the field; however, the bags meansure the same number of catties. The rice that the coolie has taken out is not accounted for.

P.K. MUKHERJE Department of Physic and Astrophysic University of Delhi, Delhi-11000

Oddities in mathematics

Foot

In ancient times, a foot was a bit more than 12 inches. The length of the foot the Greeks used was only 114 inches. Archaeologists and engineers were able to figure out this length by studying the ruins of the temples that the Greeks built and by making thousands of careful measurements. The Romans spread his short foot measurement all hrough Europe, where it is still used. The 12-inch foot that we use s a standard only in English-speakng countries. In other places, a oot is of any length-from 11 to 14 nches.

Yard

An old measure of cloth that was used before yard was the 'ell'. This varied from 24 to 48 inches. The ell' has been used as a measure since Biblical times. In the tenth century, King Edgar of England standardized

the ell at 36 inches, so that it became a yard.

Button-size

There is a special way of measuring the buttons that we have on our clothes. The size of a button is measured by its diameter or width. The unit of measurement is called 'line'. It is 1/40 inch. A 16-line button, for instance, would be 16 times 1/40, or 2/5 inch wide.

Funny acre

An acre was originally the amount of land a yoke of oxen could plough in one day. So it varied a great deal, depending on whether the farmer and his oxen were lazy or efficient. This forced Henry VIII of England to limit an acre to an exact size. It was the area of a piece of land 40 measuring rods long by 4 rods broad, each rod being 5½ yards long. During the Middle

Science Crossword Puzzle (Minerals)

13

14

10

45

16

22

20

CLUES

Acres

- 1 A sulphide ore of cobalt.
- 5 A hydrated oxide of magnesium.
- 12 A mineral of beryllium.
- 18 An anhydrous sulphate mineral of calcium.
- 20 A carbonate mineral of magnesium.
- 21 A sulphide mineral of ruthenium and osmium.
- 22 A mineral of tantalum.
- 23 A mineral containing sulphides of platinum, palladium and nickel.
- 24 An oxide mineral of niobium.

Down

- A silicate mineral of lithium.
- 2 A mineral of titanium.
- 3 A chloride mineral of magnesium.
- 4 A hydrous magnesium silicate.
- 6 An oxide mineral of titanium.
- 7 An oxidised uranium mineral.
- 8 A phosphate mineral of lethium.
- 9 An intimate mixture of granular corundum and magnetite.
- 10 A hydrated sulphate mineral of calcium.
- 11 A sulphate mineral of strontium.
- 12 A mineral of barium.
- 13 A mineral of molybdenum.
- 14 An oxide mineral of aluminium
- 15 A sulphide mineral of lead.
- 16 A fluoride containing phosphate mineral.
- 17 A silicate of potassium and aluminium.
- 19 A sulphide mineral of arsenic

R.C. KAPOO Chemistry Department Christ Church Colleg Kanpur-20800



SCIENCE IN NOTES

Making mines safer

TOXIC and explosive gases like methane, carbon monoxide, carbon dioxide, hydrogen sulphide, etc., in the mine atmosphere pose serious danger to the mine and the personnel engaged in mining operations. Facilities have been provided for regular analysis of mine gases so that timely precaution can be taken when needed.

For on-the-spot analysis of such gases, detector tubes for carbon monoxide and hydrogen sulphide have been developed by the Central Mining Research Station, Dhanbad. The working principle of the portable methanometer developed by CMRS is based on catalytic oxidation

of methane at low temperature. This instrument can be used for on-the-spot detection of methane in the range of 0 to 5 per cent with an accuracy of ±0.05 per cent. This instrument is light in weight, sturdy and intrinsically safe. Single and multistation methane sensor unit has been developed for continuous methane monitoring.

A leakproof method of sealing the interior of a bore hole at any desired depth has been evolved. The Rescalite, a new promoter administered catalyst, has been developed for oxidation of carbon monoxide at ambient temperature. It can mainly be utilised in 'self-rescuers' and other

industrial gas masks. It will als replace imported chemicals used for similar purpose. Moreover, under some severe conditions it has got his gher efficiency compared to imported product available in the market A rescue mask has also been developed.

Coal mines with gas content of about 10 cu m per ton or more can not work productively without gas drainage or degasification of the seam. C.M.R.S. has developed know-how for detailed investigation on gas emission, and carried out test with regard to some gassy mines lit has also developed complete know-how for designing degasification units and installed a pilot degasification unit.

Rain-gauze telemetry system

COR flood forecasting, the rain fall information from various catchment areas has to be monitore at frequent intervals of time. The river catchment areas are at remove locations and are normally inaccess ble during monsoon. What required is an automatic system which can measure the rainfal store the rainfall data and transm it to a distant control station a regular intervals. The Nation Aeronautic Laboratories, Bangalor has developed a complete rain gaug telemetry system for this purpos The complete system operates on di cells and can continuously wor unattended over a period of s months. Ten such systems have been installed and field-tested (Tista catchment) an Sikkim Madhya Pradesh (Narbada catch ment) during the last two monsoo scasons.



N. Walker, Butterworths, London and Joston, 1975, pp. 262, £ 10.00.

THIS book is a collaborative effort of present and past numbers of the Soil Microbiology pepartment of Rothamsted Experimental Station. The book is divided nto 12 topics and each topic is not the form of an essay written by individual authors who are specialists that field.

A variable proportion of soil nicroorganisms consists of anaerobic nicrobes of which some have the bility of growth only in the absence f oxygen (obligate anaerobes) while thers can live and grow in the resence of oxygen, or can live naerobically when suitable nutrients re supplied (facultative anaerobes). agricultural microbiologists, or oil anaerobes, which have the ability fix nitrogen, decompose cellulose r reduce sulphate to sulphide or itrate to gaseous nitrogen, are of rime importance. The activities f these bacteria and the roles they lay in soil are beautifully described. hizobium plays a great role in the xation of nitrogen by leguminous lants. The problem associated with oculation of Rhizobium in soils and ne role of soil protozoa and soil ingi have been described. Nonmbiotic nitrogen fixation in mainining soil fertility is important, and ne last chapter which is devoted this topic has been excellently resented.

Every chapter at the end has references upto 1975; in some of the chapters additional references for further reading are also given. The book presents information on soil microbiology in a nutshell, and as such it cannot be used as a text book. But, this constitutes a useful reading material for introduction to various aspects of microbiological research.

Professor of Microbiology
Bose Institute, Calcutta 700009

DEVELOPMENT OF THE FROG by C.B. Power and J.D. Sahasrabuddhe, Saroj Prakashan, Saroj, Ramdas peth, Nagpur, Pp. 120, Rs. 8.00, 1975.

THE similarity of various essential components of the body of a frog with a human body has provided a special tool to zoologists. Its easy availability is a further advantage in the study of its embryological development in relation to man. The book is an attempt to provide a detailed account of histology, anatomy and physiology of the frog with a special stress on its embryological development.

The book has been divided into seventeen chapters mainly dealing with life-history of frogs; maturation and structure of gametes; fertilization; cleavage, the blastula; gastrulation; organisers; fate of three gerna layer; development of the digestive system, respiratory system, circulatory system; excretory system, reproductory system, nervous system and the development of sense organs.

An essential characteristic of any good zoology book is that it should be simple, and give sufficient diagrams. This book possesses all such qualities. In addition, the book presents the summary of the details in tabular form which would be surely welcomed by the users of the book. It also provides first hand

organogeny of the frog. The style language, and the terms used in the book are simple. It is useful as text-book for under-graduate student of an Indian University.

> S.P. MAZUMDA S.S.O., Project Directo Krishi Bhava Bikaner-33400

THE MICROBIOLOGY OF THE ATMOSPHERE (2nd Edition 1973 by P.H. Gregory, Leonard Hill Book Great Britain, Pp. xxi +377, R. 150.00.

A ICROBIOLOGY of atmos IVI phere or rather aerobiolog is concerned with the study of micro-organisms, the airborne identification, behaviour, manner of movement and survival. According to the author this book is a eloborated version of Intercollegia Lectures given to students of botan University of London, in 1956. Th book describes nearly all the facets of aerobiology including the propertie of the atmosphere, as well as th properties of the microbes then selves. The dispersal of these of ganisms through air, their survive in the atmosphere as well as o ground have been discussed the roughly. Some microbes in the a can also cause allergy in huma beings and the chapter dealing o this subject describes these microbe and their role in producing variou types of allergenic reactions. Cro disease epidemics have also bee discussed, since the transport of airborne microbes over a long dis tance may produce crop diseases i remote areas. The book also des cribes certain techniques for air sampling. It seems the author ha taken great pains in writing thi book and has presented valuable data on all aspects of aerobiology It has an excellent bibliography, number of colour and black and white plates showing various orga nisms like fungi, protozoa, an pollen grains. The author index and subject index appear separately.

It is one of the best books that have appeared on the subject and it will certainly prove very useful to those concerned with teaching or research on the subject.

AJIT K. MISHRA

A TEXT BOOK OF ANIMAL PHYSIOLOGY (General & Comparative Physiology & Biochemistry) by P.C. Hurkat & P.N. Mathur, S. Chand & Co., New Delhi, Pp. 624, Rs. 23.75.

WITH the advancement of modern technology, biological investigations, irrespective of their specialization, i.e., it ecology. taxonomy or cell biology, have been oriented explain the various specialized and non-specialized characteristic and non-characteristic functions at macromolecular level. Physiology

and biochemistry together are very good parameters for critically assessing the dynamic functional aspects of various biological systems. Taking into consideration such a need and trend, the author has written this basic text which will prove fruitful to students and teachers alike.

The book is comprised of 23 chapters. Each chapter is further subdivided, 'quite broadly', to provide more comprehensive account of the subject matter. The first four chapters provide a basic survey of the subject useful for the beginners. The rest of the chapters also start with simple introduction of the subject followed by detailed discussion. The analogies and diagrammatic representations are suitably placed in explanation and the subject matter is well linked up. For instance, the author has rightly compared the organized cells of biological systems with members of a society. For survival and smooth running of any society, each of its members has to

contribute work according to the best of his skill and capability while its other requirements a fulfilled by others. In other word it reans that members of a societ are interdependent. Similarly, cel ir a body cooperate. Interesting and recent advances in endocrin g ands, pheromones, neurosecretion physiology of migration, etc., further add to the value of the book.

The author should have stresse the point how diverse groups of animals adapted themselves in term of their physiology and biochemistr in order to achieve analogous an homologous adaptations.

The book will serve as a fairl good, comprehensive text for stu dents of B.Sc. (Hons). This ma also be used as an elementary refere rence book at M.Sc. level of India universities.

> VED P. AGGARWA Zoology Departmen University of Delh Delhi-11000

MEDICAL NOTES (Continued from page 568)

It is also noticed that a high proportion of the siblings of SIDS victims show an electrocardiogram abnormality, called prolonged Q-T interval. In adults, this ventricular abnormality has been linked with sudden death, and it is suggested that it may also be a factor in some cases of SIDS. The poor respiratory

control might also make a child suffer from SIDS. It can also be due to 'apnoea', a condition/period during sleep when there is no respiratory effort for several seconds. Presently but the children, due to the three different kinds of apnoea immaturity of the brain structure, occurring during sleep have been recognized.

Significantly, children with colds

are prone to prolonged sleep apnoea. In adults, the brain is well developed to overcome problems that it would encounter during sleep, are more vulnerable.

R. RAGHUNATHAN

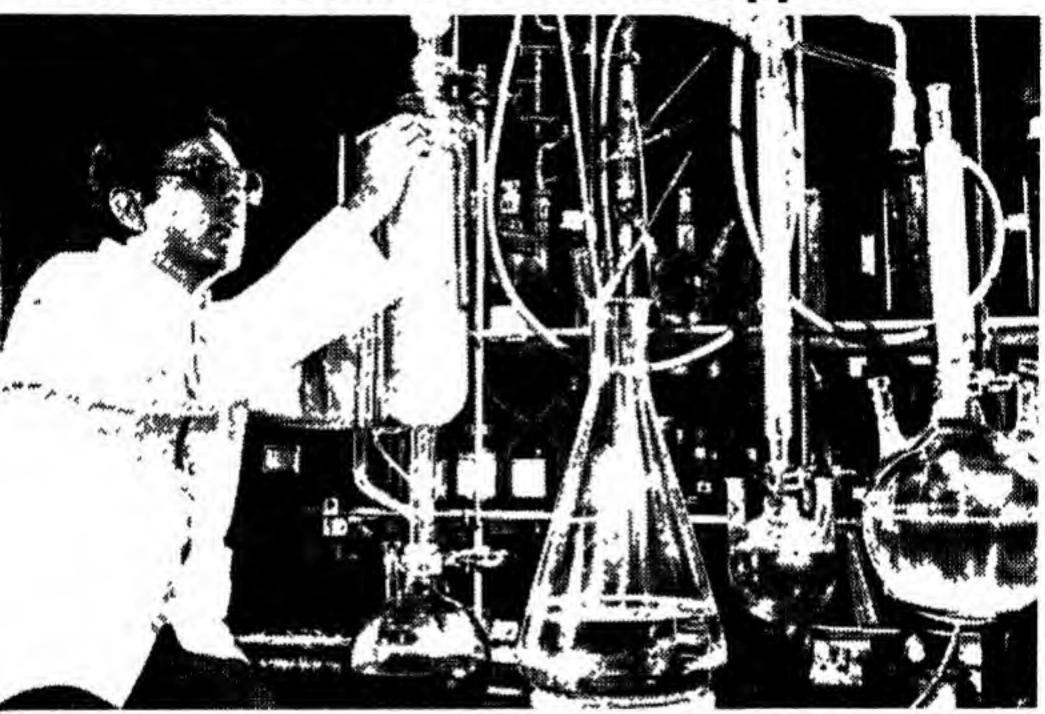
NATION REGAINS SPIRIT OF ADVENTURE 1975-76

Drive against Black Money

- The underworld of smugglers smashed. Top smugglers behind the bars; 42 smugglers declared absconding and their property seized.
- Ceilings clamped on vacant urban land. Transfers within ceilings forbidden.
- Limits on area of dwelling units set. Valuation of luxury houses to nab tax evaders. Direct taxes collection up by 27.4 per cent since July 1975, following tax raids.
- Income and wealth exceeding Rs. 15,870 million disclosed by over 250,000 declarants under Voluntary Disclosure Scheme. Tax revenue Rs. 2,490 million.

davp 76/90

'We shall leave no seed untapped."



Hindustan Lever Research and Technology have added lakhs of tonnes to our oil resources by exploring unconventional and neglected oilseeds.

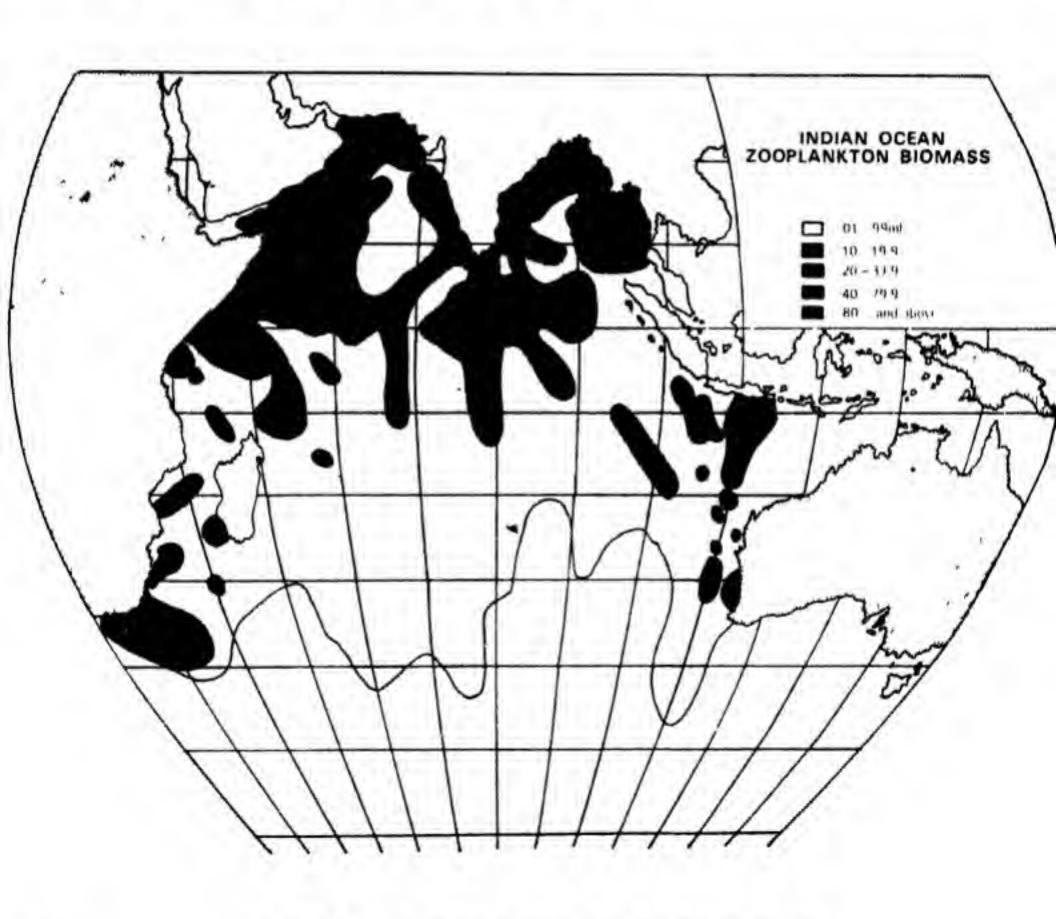
Vegetable oil is a major source of nutrition, especially for the vulnerable sections of society Yet, in India, the average consumption per head is only one-sixth of the minimum nutritional standard

This shortage of fats inspired research by Hindustan Lever scientists into the chemistry of several unconventional oils—castor, linseed, sal, neem, kusum, karanja, ricebran, etc. More than a decade of research has enabled us to modify and upgrade them for use in soapmaking and thereby release for human consumption lakhs of tonnes of edible oils which would otherwise be used in soapmaking. As most of these oilseeds are grown in backward areas, it brings employment and income where it is most needed. And without this breakthrough, the country would have been importing tallow for soapmaking Import saving on this account alone exceeds Rs. 10 crores per annum. Research creates technology that is relevant to India's needs—better nutrition, income in backward areas and import saving.

Hindustan Level Ltd. ***

Relevant Technology in the Millions

SCIENCE REPORTER



PLANKTON IN INDIAN SEAS

Re. 1.00

.00 WHY DO NUCLEONS CLING?

SWIMMERS! BEWARE OF RIP CURRENTS

CLOTHES TO SUIT CLIMATE

EYES TELL WHAT YOU ARE THINKING

DO PLANTS HAVE SENSES ?



COUNCIL OF SCIENTIFIC INDUSTRIAL RESEARCH NEW DELHI-110001

'Let there be wealth out of waste."



Hindustan Lever Research and Technology have turned a forest waste into an international product with several crores per annun of export potential—and created seasonal jobs for Adivasis.

Until a few years ago, the Sal forest was a subject for poems and pictures and little else besides.

This picture started changing for the better once Hindustan Lever's Research scientists started work on it. And an enterprising forest contractor offered to organise collection of Sal seeds in the wilds of Orissa.

Sal fat is today processed and exported as a cocoa butter extender to give the special melt-in-the-mouth property, so valued by chocolate makers of the world.

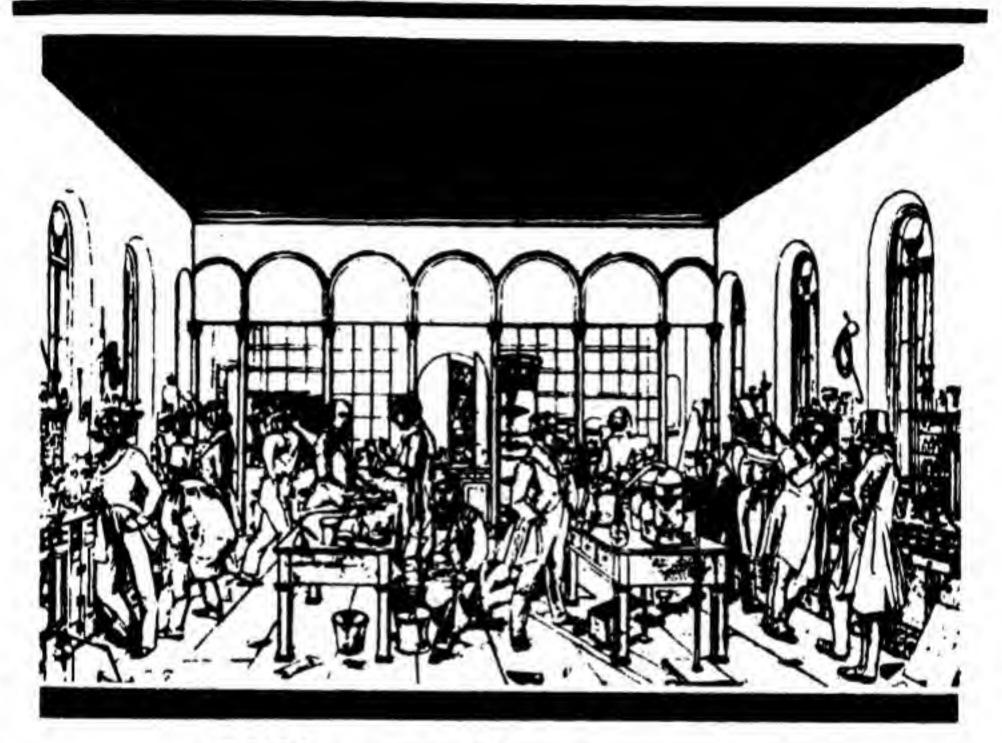
Today our enriched Sal fat exports fetch crores of foreign exchange per annum. Potential for exports could be doubled, provided the prices are competitive internationally. And it provides seasonal employment and income in backward areas for thousands of Adivasis. A good example of transfer of wealth through technology from the chocolate consumer in Europe to the Adivasi in Orissa.

Relevant Research turns yesterday's waste into today's wealth.

Hindustan Lever Ltd.

Relevant Technology for the Millions





Where the Pioneers have left

The key nature of alchemists role in laying the foundations of modern science, may be judged from only a partial list of basic scientific tools, associated with their names.

Chemistry had its origin in the laboratories of the alchemists. Alchemy eventually expired under the impact of science, but its tools and procedures were taken over by the scientists in the modern world, to utilize them for extending the basic discoveries still further and bringing them closer to the common man.



SARABHAI M. CHEMICALS

Where scientific tradition of ingenuity never dies.

to our contributors

- SCIENCE REPORTER welcomes articles of absorbing interest on science and technology. Contributions
 published in the Journal will be paid for.
- Articles should be sent to the Editor, SCIENCE REPORTER, CSIR, Rafi Marg, New Delhi-110001.
- The form and manner of presentation of the subject should be easily understandable to the undergraduate level.
- The length of the article, written exclusively for the Journal, may be about 2500 words.
- The matter should be typewritten, double space on one side of the paper; the original and a carbon copy are to be sent.
- The article should preferably be illustrated; captions and legends typed separately and attached at the end of the article. Photographs should be on glossy paper.
- While quoting names of scientists, etc., their initials, nationalities and periods of research under reference should invariably be mentioned. All weights and measures should be given in Metric Units.
- A short note about the contributor should also accompany the article. The note should contain age, academic accomplishments, important assignments held, fields of research and hobbies.
- Articles or illustrations published in the Journal can be reproduced with permission of the Editor.
- The Fditor reserves the right to reject even invited articles without assigning any reason.

SUBSCRIPTION	NC
FORM	

To

The Editor
SCIENCE REPORTER
C.S.I.R., New Delhi-110001

Name		
Full Address		
(in capitals)	- Sec	
- + -1	PIN	
(Old Subscription No	50.33.80	Signature
	Subresintian No. in N.	() second also



over: Areas rich in zooplankton

ience Reporter is insued monthly.

he Council of Scientific & Industrial

ivanced by contributors.

VOL. 13 OCTOBER 1976 NO. 10

580 LETTERS

MAIN ARTICLES

2 Why do nucleons cling? Naresh Kumar

587 Planktons from our sea T.S.S. Rao

592 Chelating agents V.V. Rama Sastry

595 Bacteria that defeat drugs N.C. Mundal

599 Ectodesmata—the new plant structures Vijav K. Sharma
O.S. Singh

602 SCIENCE SPECTRUM

X-rays from supernova remnants—High coersive force magnets—Climate and clothing—Rip currents—swimmers enemy on the beach Eye-to-eye communication—Hard and soft acids and bases—Perception in plants—Factor fallacy—Of immunoglobulins—Synthetic food additives as a source calories—Light line in leguminous seeds—Magnesium ammonium phosphate—a potential multi-nutrient fertilizer—Slag and potassium removal is coal fired MHD generator

624 NEWS AND NOTES

International Conference on chitin chitosan- International Symposium o Monsoon-Nobel nutritionist Dam passes away - Dubos, Wobman an Elton share Ecology Award- Higher wood production through tree breedin

626 MEDICAL NOTES

Cadmium—a health hazard—Synthetic double-stranded RNA as antitumou agent

628 PLANETS AND THEIR POSITIONS-NOVEMBER 1976

629 SCIENCE FOR THE YOUNG

Venomous fishes -- Biological basis of organ transplantation -- Science whee word puzzle (Chemistry)

635 SCIENCE IN INDUSTRY

Multichannel analogue strip chart recorder- Effective plant growt regulators developed

636 BOOK REVIEWS

Asimov's Guide to SCIENCE—Secondary School Physics—Elements of Computers and Computer Programming Matrices and Tensors in Physics—Fundamental Chemistry—Concise Etymological Dictionary of Chemistry—A Introduction to Pteridophyta—BOOKS RECEIVED

Annual Subscription

mland : Rs. 10.00

oreign : \$ 5.00

Editor: S.P. Ambasta Asstt. Editors: C.B. Sharma, Zaka Imam

Editorial Staff: Dilip M. Salwi, Nisha Misra Sales & Advt.: G.N. Jaswal, G.E. Salpek

Production: V.S. Chaturvedi



Female hands on books

Sir, I have long been an S.R. subscriber. So, I hope you will not object to a suggestion of mine. In the title illustration of Book Reviews you should show one male hand and the other female hand opening the book, instead of two female hands as currently being displayed. I am sure you will agree with me that the column is not meant for women only.

P. M. ACHARYA Berhampur University Berhampur-760007

The unicorn

Sir, With reference to Mr. T. Antony Davis's article Alicorn or the horn of the unicorn (S.R., April, 1976). I would like to add that the chiru or Tibetan



antelope, Pantholops hodgsoni (Abel) is also classed among the animals which gave origin to the belief of the fabled unicorn. In the bucks, the horns rise close together, diverge towards the tip and curve slightly forward (Fig. 1). The male chiru stands 80 cm at the shoulder and the long slender horns measure 60-65 cm. The horns, when seen in profile, may suggest a one-horned animal.

B.K. Behura Professor of Zoology Utkal University, Vani Vihar Bhubaneswar-751004

Dangerous peis

Sir, Apropos of Pets can be dangerous by M.L. Sood and Miss Sudarshan Kalra (S.R., April, 1976, pp. 241-45), I am reminded of an interesting incident reported by Dr. A.R.L. May of Britain (Brit. Journ. Clin. Pract., Vol. 21, Jan. 1976). A girl aged ten had a very painful hip joint. Osteomyelitis was diagnosed and accordingly drugs were given. But blood culture showed that the pain was due to an infection caused by Salmonella overchie.

The girl's history showed that she had many pets: a dog, a rabbit, a hamster, guinea pigs and a tortoise. The last one was forgotten when the history of the girl's illness was prepared. She was able to recollect that ten days before admission the tortoise had passed urine accidentally over her, leading to subsequent skin infection. The author says that the tortoise harbours not only salmonella but a multitude of other pathogens as well. It is likely that these germs had got into the blood stream and the hip joint to then reached produce the diseased conditions.

The incident not only emphasises the importance of eliciting a clear history from a patient, but also warns pet-lovers against such diseases.

> Combatore Medical College Combatore-14

Polysaccharides

Sir, I read the article Role of polysaccharides in our life by P.L. Soni (S.R. Feb., 1976). In the second paragraph, he says, "When eaten by an animal, starch and cellulose are broken down to D(+) glucose units."

This type of generalisation will create confusion. There is no specific enzyme in the digestive system of man and other higher animals which can break down cellulose into simpler components.

SABAREE MITRA Central School (IIT) New Delhi

It is true that cellulose is not digested by man and higher animals as they do not possess specific digestive enzymes for its utilisation micro In herbivorous animals, organisms (bacteria, yeasts, protozoa) in the digestive tract attack cellulose to form, among other products, lower fatty acids which the animal utilises for energy. In some species of "Shipworms" (marin wood boring mollusc), the complex carbohydrate enzyme system include a powerful enzyme cellulase which acts on woody fibres eaten by thes animals. The gut of termites harbour microorganisms, e.g., the protozoa Tryconympha which cause cellulos digestion.

> P.L. Son Research Office Wood Preservation Branch Forest Research Institut Dehra Du

Mercury pollution in India

Sir, The problem of environmental pollution due to mercury (S.R., April 1976) is potentially grave in India Unfortunately no systematic effort has so far been made to define it magnitude. Recently, the presence

oastal waters around Greater Bomay. In the fishes of Mumbra and hana creeks, Mercury has been etected in alarming proportions. I study of 58 samples of 30 species of fishes has revealed that the waters round Greater Bombay have been eceiving mercury through industrial fluents. Mercury has also been ound at an unsafe level in the nuscles and bones of fish.

The presence of mercury off the fulf of Cambay has also been reportd by scientists of Gujarat Fisheries nd Bhabha Atomic Research Centre, ombay. As reported in Science deporter, chlor-alkali plants located long the coast have been found to e the main source of mercury polluon. Out of total mercury released to the environment through these dustries, almost 97 per cent is being ischarged through waste water and udges. The study revealed that the ischarge of mercury from chlorikali plants was about 0.5-1.01 lb er ton of chlorine.

National Committee on Environnental Planning and Coordination NCEPC) has proposed to undertake survey to determine the level of nercury pollution in our coastal vaters. Such a step will be helpful taking timely action to curb the nenace of pollution due to this neavy metal.

R.R. KHAN
Scientist
Intlustrial Toxicology Res. Centre
Lucknow

Lead extraction technology

Sir, Your Science in Industry articles have always been an attraction. We are deeply interested in the subject 'Lead extraction' scheme (S.R. March, 1976). We want

some preliminary information like investment cost and capacity. Unlike previous articles in this section, you have forgotten to mention the approximate investment required, capacity and the full address of the concerned National Laboratory.

SAGAR ENGINEERING ENTERPRISE 19, D. N. Singh Road Bhagalpur City Bihar

For details, write to the National Metallurgical Laboratory, Jamshedpur.

-Ed. S.R.

Neem

Sir I read the article Neem as a medicinal plant (S.R. Feb., 1975) with some interest as well as disappointment. It has not brought out more important and valuable in formation available on this plant. I would like to give a few additional points for the benefit of S.R. readers.

A considerable amount of systematic research investigations on the different parts of the neem tree have been carried out by a team of workers headed by S.S. Siddiqui and sponsored by the Council of Scientific and Industrial Research for many years since 1942. Regarding the value of neem oil, one would find useful information in a paper presented by Chittaranjan Mitra at the Symposium on 'Indian Oils & Fats and their Utilisation' held at the National Chemical Laboratory. Poona, as early as 1951 under the auspices of the C.S.I.R. The paper contains over thirty-five references to earlier work on neem and a good flow-sheet on the products from the neem seeds. One wonders if bitter margosa oil would ever be liked 'by fatty people in controlling diabetes' (as stated in the article).

The bitter components such nimbin, nimbidin, nimbidol and nin biol from the different parts of th tree have been studied in great deta from the point of view of both the interesting structural chemistry an pharmacological actions. The mor significant are the results of research work on their uses, done at th Indian Institute of Sciences, Banga lore, under the leadership of M Sirsi. Nimbidol has been found to be more potent than nimbidin is malarial infections. Nimbidin ha antifungal activity against Tine rubrum and bactericidal action agains Mycobacterium tuberculosis H, R, Sodium nimbidinate, a water solubl compound, has effective spermicids action, an observation useful in family planning (Symposium of Utilisation of Indian Medicinal Plants Central Drug Research Institute Lucknow, 1957 and Ind. J. Med Sci., 1959).

Quercetin is not the only yellow compound found in neem. Beside quercetin, there are other flavonoic pigments identified in neem flower as kaempferol and myricetin. Recently from our JIPMER laboratories, we have reported the isolation of a new glycoside of myricetin named melicitrin, from the fresh flowers of neem (Ind. J. Chem. 1972. 10, 452).

By no measure, the additional information given above is exhaustive Indeed, an up-to-date and complete account on all aspects of this valuable medicinal plant would be helpfu for the utilisation of this wealth of India.

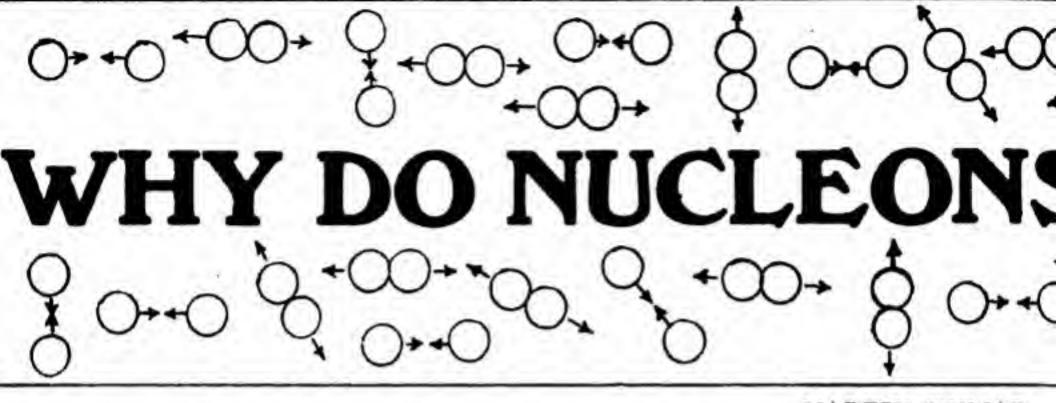
S. SANKARA SUBRAMANIAN

Professor of Chemistry

Jawaharlal Institute of Postgraduate

Medl. Edn. & Research

Pondicherry-605006



NARESH KUMAR

The exact nature of the forces which "glue" the nucleons together within the nucleus of an atom has baffled physicists for a long time. These forces, acting along very short distances, can be both attractive and repulsive depending on the distance between the nucleons

HANS A. BETHE (U.S.A.), a Nobel Laureate, once remarked that the problem—"What holds he atomic nucleus together, and what is its structure?"—has consumed nore man-hours than any other cientific question in the history of mankind.

Ever since the discovery of the nucleus in 1911 by Ernest Rutherord (U. K.), physicists have tried o study the nature of forces which bind the nuclear particles ogether within the nucleus of an tom. The discovery of neutrons y James Chadwick (U.K.) in 1932 rave a new direction to these searches is it suggested to the scientific world hat the building blocks of the nucleus are protons and neutrons (collectively alled as nucleons), and not protons and electrons as was the notion earlier. t is only after four decades of extenive research in this field that today fair knowledge of the forces which perate between the nucleons, and old them together, has been gained.

new force

Before nuclear physics came into eing, only two fundamental forces were known in physics, namely, the gravitational and the electromagnetic. It was clear to nuclear physicists from the very beginning that both these forces would be present even within the small volume (~10-30 cm3) of a nucleus, as nucleons have a finite rest mass (~1.6×10-24g) and protons have a finite positive electrical charge $(4.8 \times 10^{-10} \text{ esu})$. The attractive gravitational force in the realm of nuclear dimensions (~10-13 cm) was calculated to be very weak as compared to the repulsive electrostatic force between the protons. It was apparent that unless some other strong and attractive force acts between the nucleons, the repulsive electrostatic forces between the protons would make them "fly away" from each other tearing the atomic nuclei apart. This new force, now called the nuclear force, is the third basic force in physics and is the strongest of all. At a distance of 1 fm (1 fermi = 10-13 cm) the relative strengths of nuclear, electrostatic and gravitational forces are 1, 0.03 and 10-13 respectively.

Both the gravitational and the electromagnetic forces obey the

famous inverse square law of force, i.e., F
otin
o

An atomic nucleus is a complex and densely packed structure containing a large number of nucleons, say, from I to about 240. The study of the forces between nucleons presents enormous difficulties, as there could simultaneously prevail independent forces between two, three, four or more nucleons taken together. To begin with, two significant assumptions were made regarding the nuclear forces: (i) nuclear forces are of the two-body type, i.e., the nucleons interact in pairs only; and (ii) the force between two free nucleons (when other nucleons are not present nearby) is equal to the force between two nucleons embedded in a nucleus.

Nowadays the attention of nuclear physicists is focussed on obtaining a link between the characteristics of the "real" nuclear force to the one obtained by using the above assumptions. Present researches indicate that the main part of nuclear

· Kumer teaches physics at Hindu College, Delhi University.



force is of the two-body type, implying thereby that three-body or manybody forces are weak; and that the force between two nucleons in a nucleus is not much different from the force between two free nucleons.

Nature has provided us only with one "readymade" bound two-nucleon system. It is the deuteron. The properties of deuteron could provide information only about the neutron-proton force at large distances. The main features of nuclear force known today have been gathered from scattering experiments (Fig. 1), in which a beam of neutrons or protons at high-energies is shot at a target usually of hydrogen. Neutrons or protons colliding against protons in hydrogen get scattered in various

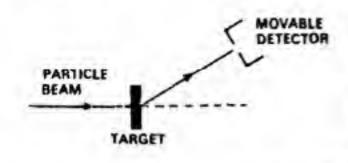


Fig. 1. Schematic representation of a scatteriog experiment

directions. Their number in every direction is counted by the use of various detectors. Though scattering experiments look simple, an enormous effort has gone in designing and performing them. Once the experimental data are available, theoretical physicists have to devise mathematical tools for handling the data. They have usually to call on the services of fast electronic computers to carry out complicated computations. This explains why it has taken so long to determine the fundamental interaction between the nucleons.

The basic philosophy behind a scattering experiment is that when we shoot a nucleon against another at a high speed, they come very close to each other for a brief moment; they "experience" the force and separate again. Properties of the force are judged from the behaviour of nucleons in such close encounters.

Characteristic properties

Scattering experiments reveal the following about the nuclear forces.

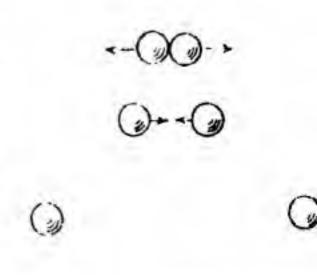
The nuclear forces are short-ranged. The range of the nuclear force is usually taken as 1.4 fm, where its stien; th drops off to about one third of a maximum value. At a distance of about 4.2 fm, the nuclear force is a mail, zero. If the pravitational of electromagnetic forces are, on the contrary, long tauge forces.

The force between a neutron (n) and a proton (p) is identical to the force between two protons (if allowance is made for the Coulomb repulsive force between protons) or two neutrons if they are in the same state of motion. Nuclear forces are therefore charge-independent.

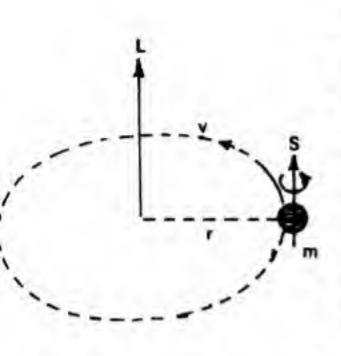
Nuclear forces, though strongly attractive at a distance of about I fm, become highly requisive at a distance of about 0.4 fm. If a were not so, under the action of strong attractive forces the nucleons would come very close together and the whole nucleus would "collapse" to a size which it

equivalent to the range of nuclear forces. In such a situation the size of a nucleus would become independent of the number of nucleons it contains, which is contrary to experimental observation. The distance of 0.4 fm is usually referred to as the hard core. The existence of hard core does not imply that nuclear forces are repulsive. On the whole they are always attractive. The two gravitational force between masses is always attractive; electrostatic force between two charges is either only attractive, or only repulsive, depending on the polarities of two charges; but the nuclear force can be both attractive and repulsive depending on the distance between the two nucleons (Fig. 2).

Data on binding energies and radii of nuclei indicate that nuclear forces do saturate. In other words, they show the property of "limited-attraction". By this it is meant that each nucleon in a nucleus interacts with only a few nearby ones, rather than with all from one end of the nucleus to another. Unlike nuclear forces gravitational and electromagnetic forces are, however, not selective it their behaviour. In 1932, to explain the saturation property of nuclear forces, Werner Heisenberg (Germany introduced the concept of exhange forces, by virtue of which the interact ing nucleons could exchange eithe their position, or spin, or both in about half of their interactions.



h 1, 2, 1 con the the hardstowers t



Angular momentum of a nucleon.

Angular momentum of a nucleon of mass m moving with a velocity v in an orbit of radius r is m v × r. L and S represent orbital and spin vectors respectively

Like the motions of the earth round the sun, each nucleon exhibits wo kinds of motion; a curvilinear notion in some specified orbit and a otatory motion about itself called he orbital and the spin motions, espectively. They are usually repreented by the directions of their ngular momentum vectors, which oint along the axes about which he nucleon executes the orbital and he spin motions (Fig. 3). The spin notion is of two types: clockwise nd anti-clockwise. Because of only nese two possibilities, spin motions f two nucleons can be only either arallel or anti-parallel to each other.

The gravitational force is central in haracter as it depends only on the distance between the attracting masses and not on their relative direction. The magnetic force, on the other and, is non-central as it depends not only on the distance between the magnets, but also on their relative directions with respect to their north-touth axes (Fig. 4). The nuclear force, however, is partly central and partly non-central. Of the two parts, the central part is the dominant one. The nuclear force between a pair of nucleons, when their spins are

anti-parallel to each other, can only be central. This is because in such a case the nucleon spins cancel out and there is no reference direction. When the nucleon spins are parallel, the resultant spin provides a reference direction and so both central and non-central forces act between the nucleons.

The central force between two nucleons for the same orbital motion is greater when the nucleon spins are parallel than when they are anti-parallel. This is usually referred to as the spin-dependence of nuclear forces. The central force between two nucleons is therefore different from other central forces such as in gravity, because its magnitude depends on the relative spin directions of the nucleons.

The non-central part of the nuclear force has two components. A component of the two-nucleon force which depends on the relative direction of their orbit with respect to their spin is called the spin-orbit force. The other, which depends on the directions of their spin relative to the direction of the line joining them, is called the tensor force. Both spin-orbit and tensor forces act only when the nucleon spins are parallel to each other.

The story, though has grown complicated, does not end here. Most analyses [like that of T. Hamada (Japan) and I.D. Johnston (Australia) carried out in 1962] of the two-nucleon scattering data (in the form of two-nucleon phase-shifts) up to

about 350 MeV (1 MeV=1.6 × 10⁻¹ erg) involve some complicated quadratic forces apart from the central spin-orbit and tensor forces. Though these quadratic forces are combinations of central and spin-orbit forces, yet their introduction does complicate the matter further. Ever after the introduction of quadratic terms, the general characteristic of the nuclear force remain the same as discussed above.

Meson theory

To explain the phenomenon o nuclear forces Hideki Yukawa, Japanese physicist, postulated in 193 an exchange of particles, of mas about 200 times the mass of a electron, between the nucleons. Thi suggestion was based on an analog with the mechanism of electromagne tic forces between electrical charges Instead of imagining the force between two charges as being due to the line of force distributed in space, on could picture the force as being du to an emission of photons from on charge and their subsequent absorp tion by another.

The particles which could act a "carriers" of the nuclear force wer observed for the first time in 194 in cosmic rays by a team of scientist [C.F. Powell (U.K.), C.M.G. Latte (Brazil) and G.P.S. Ochiallini (Italy) of the Bristol University, U.K. Thesparticles, now called w-mesons (opions), have a mass about 270 time the mass of an electron. There are three types of pions: positively

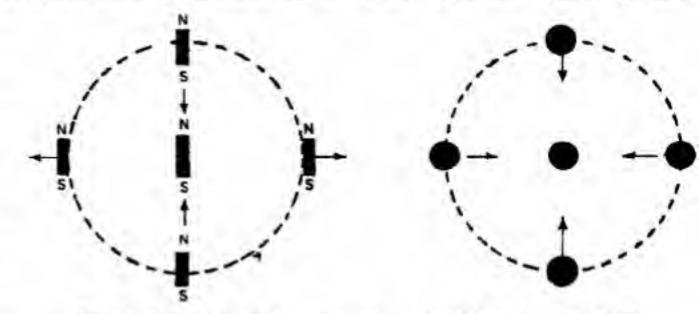
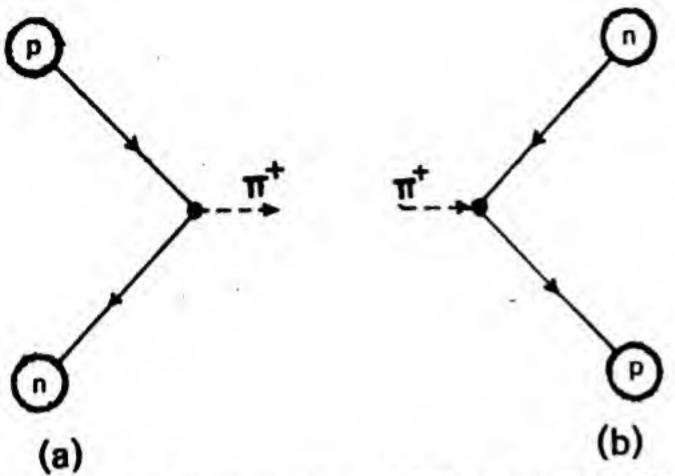


Fig. 4. Comparison of forces due to magnetism (left) and gravity (right)



Transformation of (a) a proton into a neutron by (virtual) emission of a +ve pion,
 (b) a neutron into a proton by its (vitual) absorption

charged (**), negatively charged (**) and electrically neutral (**).

According to Yukawa's theory, the force between a neutron and a proton is due to a meson field between the two. A proton emits a #+ which is subsequently absorbed by a neutron (Fig. 5). Or a neutron emits a w- which is absorbed by a proton. The pion in this process stays free for such a short time that it remains undetected. This process is virtual as it is not allowed by mass conservation. The emission of a pion by one nucleon and its subsequent absorption by another, or vice versa, continues indefinitely providing a basis for the force between the two.

The proton on giving its charge to a pion transforms into a neutron, and the neutron on receiving it transforms into a proton. This is possible as proton and neutron are similar particles differing only in electrical charge. The entire thing amounts to an interchange of positions for the two (neutron and proton) explaining the mechanism of an exchange force.

The two nucleons can interact via three types of exchange, viz., through

an interchange of positions (or space coordinates), spin, or both. The forces resulting from these exchanges are called the Majorana, Bartlett and Heisenberg forces respectively. These nomenclatures are in honour of the scientists who first

introduced these exchanges in their researches. If the nucleons interact without involving any interchange, the resulting force is called the ordinary force or the Wigner force. Different types of exchange between the nucleons are depicted in Fig. 6.

Experiments indicate that the nuclear force is a mixture of about half exchange and half ordinary force. This is possible if the pion on emission, say, from a proton, has an equal chance of absorption by either its parent proton or a nearby interacting neutron. All three types of interchange, viz., Majorana, Bartlett and Heisenberg, contribute to the exchange part. Studies on complex nuclei indicate that of the three, the Majorana component is the dominant one.

The force between a neutron and a proton is due to an exchange of +ve and -ve pions, while that due to an exchange of neutral pions between two protons or two neutrons. Yukawa's idea that pions act as "agents" of the nuclear force is supported by experiments on colli-

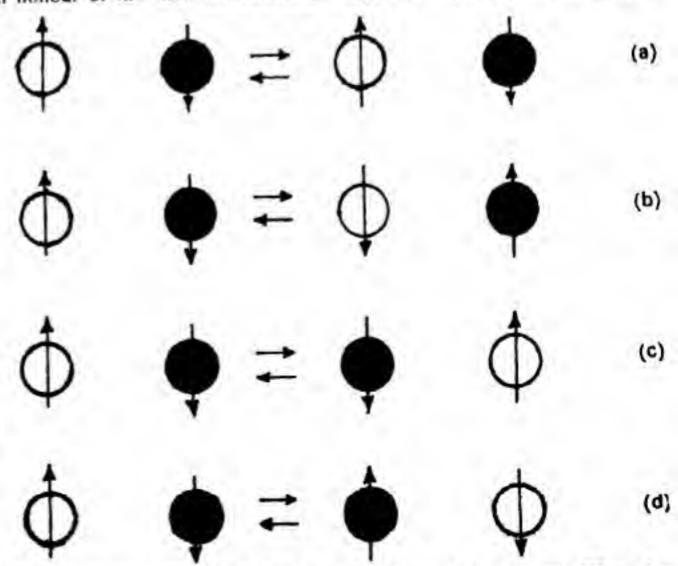


Fig. 6. Bifferent types of exchange between nucleons: (a) no exchange (Wigner force)
(b) spin exchange (Bartlett force), (c) space exchange (Majorana force), at
(d) both exchange (Heisenberg force). Unstanded circles represent protons at
shaded circles represent neutrons.

ons of nucleons at very high energies ≥1000 MeV). In such collisions very large number of pions are enerated.

The emission of a pion of rest mass mw involves a transformation of energy mπc² (from Einstein's mass-energy relationship) from one nucleon to another. This much nergy in a transformation of the type

or mass) conservation. How is hen such an emission possible? According to Heisenberg's uncertainty principle ($\triangle E. \triangle T \sim h$), if the emitted at gets reabsorbed within a time $\triangle t$, then the energy of the system cannot be determined to an accuracy greater than $\triangle E$. This suggests,

Δ1~h/ΔΕ ~h/mπc2

During this period the meson cannot cover a distance greater than

On inserting the values of $m\pi$, the pion mass, c, the velocity of light, and, the Planck's constant divided by 2π , the above expression gives the range of the meson field, and so of the nuclear force. It is $\sim 1.3 \times 10^{-13}$ cm, which is in excellent agreement with experiments.

It is now believed that the nuclear force between any two nucleons is propagated not only by pions, but also by some heavier mesons like the P, w an 7 mesons. These mesons may be regarded as combinations (resonances) of two or three pions. Exchange of these particles gives rise to shorter range forces which are observed in nuclear collisions at very high energies.

Present researches

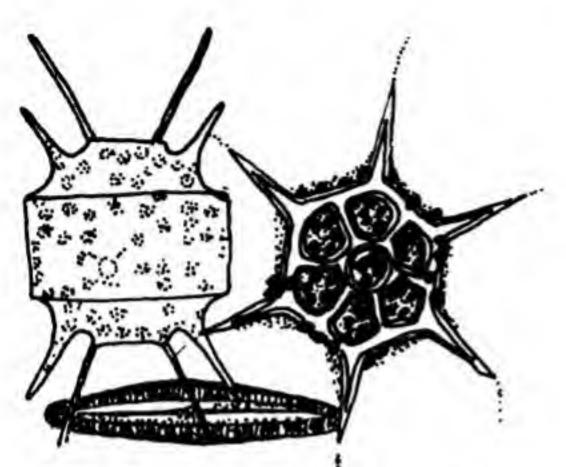
Various analyses of two-nucleon scattering data and the deuteron properties have by now provided a fairly good knowledge of the force between two free nucleons. Nuclear physicists are now engaged in extracting a connection between this force and the actual force between the nucleons within the nucleus. The usual approach followed is to calculate the properties of complex nuclei starting from the information gathered from two-nucleon scattering data. An effort is then made to bridge the gap between the calculated and the observed properties by including various corrections, which may be supposed to include the effects of other nearby nucleons or the ones due to the many-body forces. The story is still far from complete and it may take several years before we have a clear picture of these forces. However, the present researches indicate that the force between two nucleons 'in a nucleus' is not much different from the force between the two free nucleons and that the many-body force is weak as compared to the two-body force.

Researches related to the origin of nuclear forces based on the meson theory are now mainly concerned with the role played by the heavier mesons and the two-pion exchanges in the middle region around 0.7 fm.

Though researches in the above two branches usually go quite independent of each other, yet it is clear that our knowledge of the nuclear forces would be complete only when we are able to derive their properties from the meson theory. The mathematical complexities involved have so far prevented physicists from achieving a success in this aim, but we do hope that the day is not too far off!

Further reading

- Marshak, R.E., The Nuclear Force, Scientific American, 202, 98 (March 1960).
- Brink, D.M., Nuclear Forces, Pergamon Press, London (1965).
- Arya, A.P., Fundamentals of Nuclear Physics, Allyn and Bacon Inc., Boston (1968).
- Glasstone, S., Sourcebook on Atomic Energy, Affiliated East-West Press, New Delhi (1971).
- Cohen, B.L., Concepts of Nuclear Physics, Tata-McGraw Hill, New Delhi (1971).



Plankton From Our Sea

India can harvest enormous quantities of zooplankton from the waters around her

ROM ancient times we have been harvesting large quanties of fish from the sea. The fish ibsist on small organisms (seconry producers) known as zooplankin which in their turn feed on naller plants, namely, phytoplankin (primary producers). In the st 20 years or so, considerable mount of work has been done on hytoplankton and the fish. Hower, knowledge about zooplankton scant for the following reasons: rst, it is difficult to work with zoopnkton because it has a brief period survival outside its environment. econdly, most of them are small in ze and laboratory handling requires great deal of innovation and attener

oplankton, next to phytoplankton, onstitutes the bulk of organic masses the sea (Fig. 1). Recentled

of krill (small shrimps which form the food of the whales) in the Antarctic waters at 250 million tonnes per annum. In terms of quantity this alone constitutes nearly 3-4 times the total fish landing from the world oceans. During the International Indian Ocean Expedition, standard zooplankton hauls were made at nearly 2000 stations all over the Indian Ocean. Based on this data D.H. Cushing of the Fisheries Laboratory, Lowestoft, England (1971), estimated the values of primary, secondary and tertiary production from the Indian Ocean. According to him, the tertiary level production for the two monsoon seasons from the Arabian Sea alone works out at approx. 62 million tonnes, which is equivalent to the present total world catch of fish. The zooplankton biomass which works out to ten times of this is nearly 620 million tonnes. assument I to 10 ratio between the

two trophic levels.

The question often asked can harvest th whether we enormous quantity of zooplankton directly from the sea. Many scien tists are of the opinion that plankton harvesting could not be economically feasible unless areas of increase population density are either locate Pro artifically produced. A.C. Hardy of Oxford Universit and R.S. Wimpenny of Fisherie and Food Laboratory at Lowestof however, do not consider this probler settled. There is also a suggestion for using a "mechanical whale", i.e., a apparatus which would engu water and press out plankton mor or less in the fashion of whale

War, the Biological Institute as Helgoland, Germany investigate the possibility of harvesting plankton a new source of food for the man market in 1911 Sir John

Fraham Kerr (U.K.) proposed the onstitution of a special committee o investigate plankton problem. and, Sir A. C. Hardy in 1941 sugested that plankton could serve s a source of food in England luring the wartime food shortages. It is well-known that the leader of the Kon Tiki Expedition across he Pacific proved that plankton ormed a suitable food material. On a trip across the Atlantic, Alian Bombard (U.S.A., 1953) changed his normal diet to plankton caught in ine nets. He said, "it tasted like obster, at times like shrimp, and at imes like some vegetable".

(i. Clarke (U.S.A) in 1948 made detailed study of the nutritional alue of marine zooplankton to use as an emergency food. His onclusions were that:

(i) a quantity of 5-11 grams of (dry wt.) plankton could be obtained per hour from a raft in the sea;

(ii) the dry plankton contained 52", 59", protein, 1%-4% fat, 13", 17% carbohydrate and 19", 33", ash;

(iii) the rats fed no plankton lost weight rapidly and died within 4-19 days, but survived 30", longer than starved rats.

More recently, the studies of two sulgarian scientists have revealed hat zoopiankton is a food of high nutritional value which helps vercome the deleterious effects of nutritional deficiency. During their speditions, they consumed zooplankton following a specially programmed diet. Results of their expeditions showed that raw zooplankton an serve as a basic nutrient.

The chemical compostion of hytoplankton is highly suitable to basic food according to J.E.G. taymont, of Southampton University More so is zooplankton. Table I shows that ash content is igher in the phytoplankton than zooplankton.

Moreover, protein and fat contents are higher in zooplankton and therefore, it is a more suitable material for harvesting than phytoplankton.

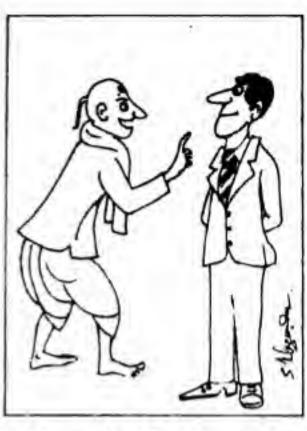
Raymont and his co-workers of Southampton University, (U.K.) have made important contributions to our knowledge of the biochemistry of marine zooplankton. As euphausids constitute an important exploitable group of zooplankton, the biochemical values of the euphausid Megany-ctiphanes norvegica make an interesting reading. In the Scottish waters this species showed an average biochemical composition of 57% protein. 17% lipid, 2% carbohydate, 16% ash and 4% chitin in terms of dry weight.

Carotenoids and vitamins are also present in large quantities in zooplankton. Table 2 shows that euphausids have high concentrations of vitamin A.

It is estimated that vitamin A content in the eye of euphausid is equal to 12000 international units per gram dry weight of body tissue as compared to 70 units found in mammals.

Many kinds of fishes, particularly clupeoids, whales and some of the sharks exclusively feed on plankton. A blue whale can grow from 25 tonnes to 87 tonnes in two years by feeding exclusively on plankton. This rate of growth requires at least 110 quarts of plankton per day (excluding respiratory requirements). An annual catch of 5,50,000 tonnes of sardines off the California coast has been estimated to need at least 15 million tonnes of zooplankton per year for support. It is estimated that in the North Sea about two million tonnes of herring should have subsisted on 50-60 million tonnes of zooplankton annually (L.A. Walford of U.S. Fish and Wild life Service. U.S.A. 1958).

It is clear that zooplankton can sustain a large population of fishes which act, as far as man is concerned, as intermediaries for converting

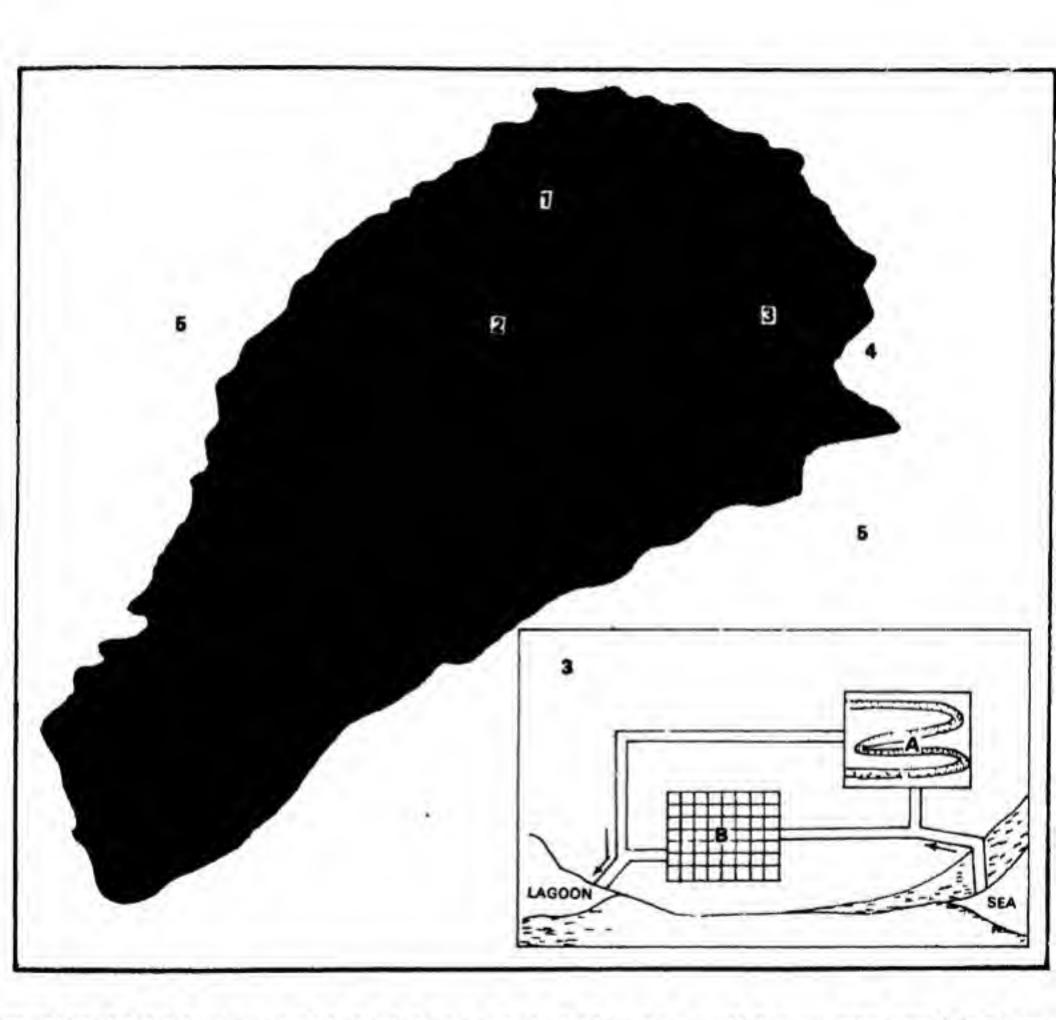


"But have they found out whether plankton as food will be vegetarian of non-vegetariam?"

zooplankton into edible protei The fishes do this freely for us, be the efficiency of conversion appea to be low. As already pointed ou it works out to about 10%, of the available stock. The importan question before us is whether w can do better than fishes in direct harvesting plankton or, alternatel assist them in gettin can more plankton at the right time s that they grow well and mortalit is reduced due to starvation?

Philip Jackson of U.S.A. (1954 estimated the probable cost of plankton fishing, by assuming a population density 0. average g/m3 (dry wt.), at \$5040 to \$840 per dry ton. This is an uneconom cal figure. Improvement on thi figure is possible only if we ca bring about novel methods of plank ton catching or associating plank ton catching with the existing opera tion of ships or offshore project where large quantities of sea wate ere taken in for cooling purpose Table 3 gives the estimated yield of plankton by various collecting devices.

It is clear from Table 3 that hesides being uneconomical, the quantity of plankton caught by the existing devices is not high.



avaratti Island (Lakubadweep group) with inset (3) showing a simple plan for using the cold deep sea water pumped from locative cold deep sea water pumped from locative cold by the shore of the depth is nearly 400 meters at a distance of 1000 meters from the shore. A. Condenser to extract fresh water, B. Hot complex or industrial unit where cold water is used for cooling or air-conditioning; 1. Coral reef, 2. Lagoon, 3. Arabian Section 1.

bundance of plankton around India Before any steps are taken to evelop methods for the exploitaon of plankton, it is necessary to exate the occurrence and abundance of plankton in the sea. During the international Indian Ocean Expeition it was found that the areas of upwelling and equatorial divergen-

ces in the Indian Ocean are rich in plankton. The plankton atlases published in 1969-72 (Cover) by the Indian Ocean Biological Centre at Cochin reveal that the Somali and Arabian coasts, west coast of India, south Ceylonese waters, parts of Bay of Bengal, and south Java sea are rich in plankton.

From the concentration of plankton in all these areas, the total biomas for each 5° square works out a several million tonnes per year Exploitation methods

As noted in Table 3, direct collection of plankton is uneconomical besides being time consuming. This approach should be combined with

Table 1. Organic content of plankton (dry weight)

	Protein %	Fat %	Carbohy- drate %	Ash%	P.O. %	Nitrogen %
ooplankton						
Copepods	70.9-77.0	4.6-19.2	0.4 -4	4.2- 6.4	0.9-2.6	11.1-12.0
Sagittae	69.6	1.9	13.9	16.3	3.6	19.9
hytoplankto	n					
Diatoms	24.0-48.1	2.0-10.4	0.30-7	30.4-59.0	0.9-3.7	3.8- 7.6
Dinofla-		76.00				
gollates	40.9-66.2	2.4- 6.0	5.9-36.1	12.2-26.5	50.7-2.9	6.4-10.3

Table 2. Carotenoid and vitamin A content of zooplankton

	Vitamin A		Carotenolds	
	I.U./g animal	I.U./g oil	# g/g animal	Mg/g oil
Meganyctiphanes norvegica	15	680	42	1,900
Thysanoessa raschii	32	495	33	500
Pandalus bonnieri	2.1	89	24	1,000
Spirontocarus	1.0	22	27	950
Crangon allmanni	0.4	30	5	390
Crangon vulgaris	0.2	21	5	550

Table 3. Estimated yield of plankton by various collecting devices

Meshod	Reference	Dry plankton per day	
		Kg	lb
Plankton collecting ship	Hardy	125.0	275.6
Passenger liner condenser	-	28.8	63.5
Swing not	Hardy (1941)	26.7	58.9
4-1/2 metre net	Marr (1938)	27.5	60 6
Heligoland larva net (towed)	-	13.5	29.8
Harvester (2nd model)	Shropshire (1944)	16.0	35.2
metre stramin net	Clarke (1939)	7.2	15.9
deligoland larva net (vertical)		4.4	9.77
Centrifuge	Juday (1943)	0.002	0.004

Table 4. Discovery St. 5380. 10°30 'N lat., 70°37 'E long., May 14th, 1964

Depth Temp. m °C			(Phosphates) POc-P	(Nitrates)	
	Salinity %	# g at/1	#g at/1	ml/1	
bs					
0	30.26	55.67	0.15	00.1	4.35
38	29,15	35.96	0.20	00.1	4.74
66	27.36	36.24	0.30	00.1	4.32
85	24.10	35.56	1.09	13.0	2.00
104	21.87	35.42	1.62	20.3	0.91
141	18.47	35.44	2.19	23.7	0.11

rawlers, merchant ships and naval ressels as a subsidiary project. Each ship should carry a commercial version of Hardy's plankton collector and collect plankton on its way from port to port. By this

method an additional quantity of plankton can be collected and used by man either directly as food or indirectly as protein, fat, etc.

The main drawback of this method is that one cannot depend on it as a



"This is my scientific improvement on the old adage."

regular source of plankton, because the purpose of the ships is different from plankton collection. The only advantage is that plankton collected as a ship's secondar function at no extra cost, would be worthwhile to initiate pilot project of this type.

Artificial upwelling could be and ther method for bringing abou increased productivity in the sea There are places in the sea, suc as the west coast of India, wher upwelling (i.e., rising of the subsur face waters to the surface region of the sea) of subsurface water rich in nutrients takes place during February-July season every year When this happens, a chain of event such as the following normally takes place. When the nutrient rich waters reach the surface, the phytoplankton becomes abundan in the presence of sunlight. They are primary producers which synthesise carbohydrates by the process of photosynthesis. The phytoplankton forms the food of zooplankton which in turn sustain the fishes. This biological chain can be started at many places in the sea if we create upwelling conditions possible with modern technology.

Roles, et al. of U.S.A. (1971) in n interesting paper (read at the ymposium on Fertility of the Sea eld at Sao Paulo, Brazil in December 969) suggested pumping of deep ater rich in nitrates and phosphaas as part of an industrial project or producing freshwater, airconitioning and electrical power. heir suggestion included pumping f cold (6°C-7°C) deep offshore ater from a depth of nearly 000 metres through a pipeline nd use it as a coolant in a essil fuel or nuclear generating lant and also in air-conditioning stems for a hotel complex. The esh water as a byproduct of the ir-conditioning system is stored a reservoir. Then this nutrientch deep water, unchanged except temperature, is piped to artificial onds for the growth of phytoplanton and onset of subsequent biogical chain. They conducted these speriments in Virgin Islands (St. roin) where water at 1000 meters epth is about a kilometre from shore.

In experiments using the plant ell Skeletonema costatum, they roved that while no phytoplankton growth took place in the surface waters at a station, its production went up as much as 27 times if deep water from the same station was brought up.

We can plan a similar experiment off our Laccadive Islands. Here the deep water rich in phosphates and nitrates is within 200 metres of the surface and hardly 1000 metres from the shore. The nearby lagoon can be converted as an experimental pond. Given above is the hydrographic data for a deep station near Laccadives (Table 4).

From Table 4 it is seen that P and N values increase below a depth of 66 metres and we have very rich waters at 141 metres depth. It may not be an expensive proposition to pump these waters to the surface of the lagoon.

We can build a multipurpose industrial unit on Kavaratti Island. A desalination plant can be planned by using electric power generated by the difference in thermal potential available in the nearby deep sea (Table 4). The coolant for the plant may be drawn from a depth of 400 metres where the waters have a temperature of less than 15°C.

After performing its cooling function both in the generating and desalinating plant, this water rich in phosphates and nitrates can be let out into the lagoon where it will trigger the development of plankton and fish. Such an industrial complex (Fig. 3) at the Laccadive Islands will be a great advantage to the islanders. The coolant water from the deep sea can also be used to aircondition hotels and homes in the island complex.

Purther reading

- Hardy, A.C., The Open Sea—It. Natural History. Houghton Mifflin, 1971.
- Raymont, J.E.G., Plankton and Productivity in the Oceans, Oxford 1963.
- Russel-Hunter, H.D., Aquation Productivity, Macmillan, 1970.
- Steel, J.H. (Ed.) Marine Food Chains, Oliver and Boyd, Edinburgh, 1970.
- Walford, L.A., Living Resource, of the Sea, Ronald Press, New York, 1958.

MEDICAL NOTES (Continued from page 627)

ation during normal development nd carcinogenesis (J. Nat. Cancer nst., 46, III-VII, 1971). Of course, his hypothesis has yet to receive experimental support.

Whatever might be the mechanism y which polyl. polyC inhibits the evelopment of different carcinomas, this synthetic double-stranded RNA has also certain toxic effects. It is embryotoxic in rabbits and elevates concentration of serum transaminases and the prothrombin time in dogs. Besides polyl. polyC can influence microsomal mixed function oxidase activity thereby

affecting drug metabolism in mamma lian liver in vivo. So, before its application for the treatment of human neoplasms, all possible precautions must be taken to avoid or to minimise the toxic effects of this synthetic polyribonucleotide.

DIPAK KUMAR DUB



Chelating agents currently find a variety of applications in industrial processes, water treatment and agriculture

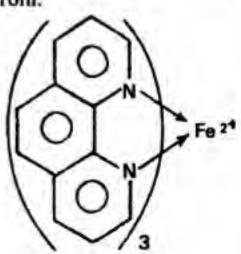
HOW do food products, cosmetics and toiletries retain their flavour, colour and clarity? What keeps wines free from turbidity? What makes detergents effective to cleanse clothes with hard water? How does hydrogen peroxide remain stable on standing? And how do rubber and polymer products maintain their colour and stability against heat and light? These and many other challenging problems faced in industrial processes have been successfully tackled by chemists with the help of chelating agents.

The study of environmental factors particularly the influence of other themical species, on the behaviour of metal ions in solution is no less important than, the study of the influence of environmental factors on tuman behavioral aspects. The arly observations that the properties of a metal ion are drastically changed or modified in the presence of other

chemical agents (those having N, S or O atoms or groups containing these atoms) have led to a thorough search of the various parameters involved. This continued search has finally grown into a whole branch of chemistry what we call today the "Co-ordination chemistry".

The modifications brought about on a metal ion in solution by suitable chemical agents are a result of complex interaction between the metal ion and the agent. This complex interaction had created a lot of interest in the minds of the 19th century chemists and, as a result, a number of theories were put forth to explain it. Less exact theories gave place to more exact ones in due course and the present day theories are quite complicated.

Let us put things in a simple way. When you add a drop of the chemical 1, 10-phenanthroline to a dilute solution of a ferrous salt, what you see is a bright red colour. Both the ferrous salt and the phenanthrolin are practically colourless, but the interaction produces a bright colour The complex obtained is identified as ferroin.



FERROIN

The normal tests for iron in ferroin fail to show its presence and for all practical purposes, it appears that no iron is present in ferroin. This is however, not true. Ferroin does contain iron, but the iron is so hidden inside that its presence cannot be detected in free state.

r. Sastry is Bevelopment Chemist at Greaves Foseco Ltd., Pune-411019

potossium addition The of yanide (KCN) to ferrous salt also eads to a complex interaction proluct, Fe(CN). This complex also loes not give tests for iron. However, it is different from ferroin, especially in one way. Fe is bound it two places on each reagent molecule in ferroin, whereas it is bound n Fe(CN). at a single place on each reagent molecule. Ferroin type complexes, unlike Fe(CN), lead o ring formations and are called chelates.

The word chelate is derived from he Greek word chele, meaning claw. The word connotes what it does. Chelates strongly hold a metal ion n a claw-like structure. When a eagent (also called ligand in comolexes chemistry) attaches itself to he metal ion at two or more possiions (called donor positions), it is eferred to as multidentate or chelatng ligand. The resulting interacion product is called a chelate. Ligands containing 2, 3, 4, 5 and 6 lonor positions are known and they are termed bidentate, tridentate, etradentate, pentadentate and hexadentate ligands. A multidentate igand is not necessarily a chelating igand. For that purpose, the donor atoms should be suitably placed on t to form stable 5 or 6-membered rings with the metal ion on chelation. The following are a few examples

of chelating agents and the way they chelate metals.

The important effects produced as a result of chelation can be summarized as follows: (a) the colour of a metal ion may deepen, fade or change; (b) an insoluble precipitate like calcium sulphate may dissolve in water on chelation, say with EDTA; (c) an insoluble precipitate (like nickel dimethyl-glyoximate) may become soluble in a water immiscible organic solvent (e.g., chloroform); and (d) unstable oxidation states may be stabilised.

The above effects of chelation are exploited to a large-extent in various fields of science, particularly in the analytical chemistry of metal ions. A full branch of analytical chemistry complexometric . (largely called EDTA) titrations has come into existence. Redox (reduction-oxidation) reactions make use of chelation either as indicators or for masking the interference of undesired ions. Gravimetric analysis makes use of the insolubility of chelate compounds while colorimetric methods are based on the appearance or disappearance of colour on chelation.

Industrial applications

Chelating agents find a large number of industrial applications though they have not been exploited to the desired extent. The industrial

applications of chelating agents a a consequence of the modification they bring about in the metal io properties. In a large number of production processes, the presence of free metal ions, even in traces, he adverse effects on the process leading to (a) lower yields, (b) metal-catalys ed side reactions, and (c) contam nation of end products. It is no always possible to remove metal ion completely from the reaction medium Chelating agents suppress metal io characteristics and the result, in effect, is as good as their physica removal from the reaction zone This process of suppressing the physi cal properties of metal ions without physically removing them is calle sequestration, and so the chelatin agents are also called sequestrants.

In recent years, our understanding of chelating agents—their structures properties and applications—has grown so much that a synthetist can make and give you a chelating agent according to your specifications. A large number of chelating agents are added to the existing list every day However, only a limited number of them currently find industrial applications, probably because of the highest costs involved with tailor-made chelating agents.

Two of the most commonly used sequestrants are the sodium salts of ethylenediamine tetra-acetic acid

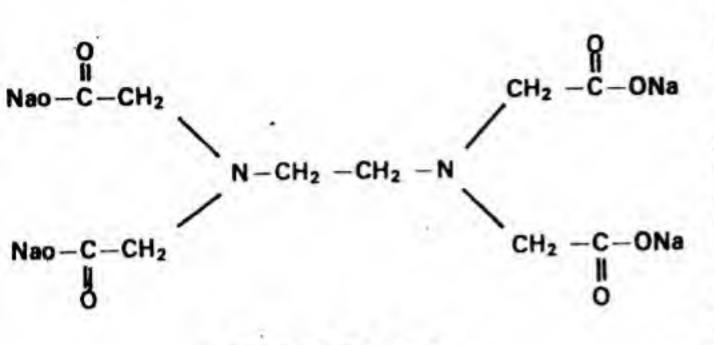
BIDENTATE

I, 10-PHENANTHROLINE

TRIDENTATE

$$\begin{array}{cccc}
COO \longrightarrow & COO \longrightarrow \\
CH_2 & CH_2 \\
\downarrow & CH_2 & \downarrow \\
-N - CH_2 - CH_2 - N \longrightarrow \\
\downarrow & CH_2 \\
\downarrow & CH_2 & \downarrow \\
COO \longrightarrow & COO \longrightarrow
\end{array}$$

HEXADENTATE Ethylene diamine tetrascetate (EDTA)



Tetra-sodiero salt of EDTA

EDTA) and nitrilo triacetic acid NTA). When the tetra-sodium salt f EDTA reacts with calcium ions t holds them in solution tightly n the chelate structure. ons such as magnesium, nd manganese are chelated and eld in solution strongly in a similar nanner by this reagent. In general, he chelates are stable over a wide of pH and temperature. ange chelating agents currently find a ariety of applications in industrial rocesses, water treatment, consumer nd household products and agriculure.

Vater softening

Sludge or scale formation is a erious defect in boilers. When helating agents are used in boiler rater treatment, the chelated metals emain in solution and no sludge is ormed. As a result, heat transfer more rapid. This is why EDTA nd NTA are used in boilers. True helating agents are costlier than onventional chemicals used for boiler rater treatment. The merits of helating agents, however, outweigh he increased chemical costs in some pecial applications. Moreover, in ome applications, the cost of chelatng agents for boiler water treatment an be minimised by the use of lonxchange pre-treatment processes on he boiler-feed water. For all general urposes, the more economical sethods such as ion-exchange and

chemical precipitation replace the use of chelating agents in water softening.

Detergent builders

Builders are materials in synthetic detergents which chelate (sequester) polyvalent metal ions present in cleaning solution, particularly Cast and Mg* ions which are present in substantial quantities in the so called hard water supplies. Over a million kilograms of builders are presently used in detergent products, particularly in textile cleaning detergents where they may constitute upto three quarters of the total weight of the product. Laundry products containing significant quantities of builders are called heavy duty or built detergents. By far the most commonly used builders are the condensed polyphosphates, particularly penta sodium tripolyphosphate (STP) and to a lesser extent tetra sodium pyrophospate. Other chelating builders such as NTA, EDTA and other

polycarboxylic acids also find us in small-to-moderate quantities.

Miscellaneous us

In textile manufacture, control
of undesirable effects of hardness and
heavy metal ions is essential as
several stages particularly cleansing
scouring, bleaching and dyeing
operations.

Chelating agents find place in agriculture in the metabolism of plants and animals, as carriers of micronutrients, particularly Fe, Zn Mn and Cu.

In pulp and paper production chelating agents help remove heavy metal ions and improve peroxide bleaching of pulp.

Traces of metal ions have adverse effects on the flavour, colour, clarity and stability of various biologica and food products. Ion control is important in these products and in cosmetics and toiletries for main taining stability, colour and clarity

In rubber and polymer products metal ions cause such undesirable effects as polymer breakdown discoloration and poor heat and light stability. Such difficulties are eliminated by small quantities of chelating agents.

EDTA is added to liquid soap for haze prevention, to hydrogen peroxid for prevention of catalytic decomposition, and to wines for turbidity contarol. Motal finishing industries make use of chelating agents for controlling contaminating ions. Exterior sur

Nao-C-CH₂

CH₂

CH₂

CCB

CH₂



Antibiotics made for the bene fit of mankind face the unanti cipated challenge posed by th drug-resistant bacteria

Bacteria That Defeat The Drugs

N.C. MANDAL

TO react to the adverse environ-mental conditions is one of the therent properties of any form of ving being. This reaction is an bvious necessity for the survival of e living organisms by adapting to e altered or adverse conditions. The sperior thinking capacity of man with is increasing curiosity and ceaseless forts to triumph over the environent results in the discovery of ultiplicity of agents which can be sed to resist different forms of nemy. The most common natural nemies of man are those which canot be seen by naked eye-the microrganisms causing diseases an. With the discovery of microcope the physical nature of the acteria has been known and they ave been studied thoroughly in the laboratory. After knowing biochemical details of the life processes of these organisms it has been possible for man to find suitable chemical agents, either synthetic or natural, which could be successfully employed to interfere with the growth of the microorganisms thereby helping cure of the disease. The common chemical agents which are routinely used in our daily life to combat these tiny enemies are antibiotics and sulpha-drugs. The discovery of these antibacterial agents promised a better form of life to the human society but this was certainly a challenge to the microbial world, the challenge for their survival and perpetuation. So it was expected that the bacteria would react to this challenge.

The bacteria developed som ways by which they could resist o counteract the lethal effects of drug and perpetuate themselves. When a antibacterial drug is used to kill particular type of bacteria, som bacteria in that population acquir drug resistance and ignore the pre sence of the drug. This mean that some bacteria in any particula sensitive population can grow eve in the presence of the antibacteris drug. In earlier days, it was though that when the bacteria are grown i the presence of a particular drug, th drug resistance property is induced i the sensitive bacteria by the men presence of the drug. Now it is we proved that the mere presence of drug does not produce the drug resistant phenotype. If it were s e probability of getting resistant pe would have been much greater nan that obtained in actual experinents. Actually what happens is nat in every population of sensitive acteria there are a few resistant cells hich result either from spontaneous nutation in their chromosome or due the acquirement of certain extrahromosomal (cytoplasmic) genetic lements in them. When such a opulation of sensitive bacteria is rown in presence of the drug the ensitive cells die while the resistant nes continue to grow and ultimately eplace the sensitive bacteria.

desistance from the mutation

There are two possible ways in which a drug may not show its inhiitory action on a resistant bacterium. Ve know that the syntheses of bioogically active macromolecules like NA, RNA, and proteins are essenal for the continuation of cell diviion and growth. Antibiotics inhiit growth of the bacterial cells y interfering with the synthetic rocess of any of the above three lasses of macromolecules. To how this inhibitory effect the drug nolecule must interact with certain arget site or component of the partiular biochemical machinery; as a esult the latter becomes misfuncional or nonfunctional. This interction of the drug with the partiular component requires certain pecific structure and conformation f both the interacting partners. If he structure of any one of them is Itered such that their interaction is o longer possible, the drug will not e able to show its inhibitory activity. to the drug resistance property in a acterium may show up if (i) a drugensitive component in the cell is ltered, or (ii) if the cell evolves some iochemical mechanisms by which can modify or degrade and thus nactivate the drug molecule upon s entry into the cell. There may be third way in which a particular ell may become impermeable to a articular drug so that the latter does not get its way to the intracellular site of its action. In the first case, as mentioned in (i) above, the alteration of any component of the macromolecular synthetic machinery is effected by mutation in the chromosomal gene regulating normal function.

Much work has been done on the molecular mechanism of antibiotics which act at the level of protein synthesis. It is well-known that the ribosome plays a mojor role in translating a messenger RNA(m-RNA) molecule into a specific protein. There are a number of antibiotics which inhibit protein synthesis. These antibiotics display their inhibitory action by interacting with the ribosome in such a way that the drug-ribosome complex is no longer able to translate the m-RNA or does some mistake in this process thereby synthesizing no protein or synthesizing some nonfunctional proteins. In the absence of biologically functional the proteins bacterial cell cannot grow. There are séveral genes in a bacterial chromosome, the protein and RNA products of which collectively maintain the normal functional ribosome. Mutation in any one of those genes in chromosome leads to the production of altered protein or RNA component of the ribosome, the ultimate effect of which is to alter the structure of ribosome in such a way that the latter cannot interact with the drug in question but still possesses the ability to translate the m-RNA correctly. So the mutant (drug resistant mutant) can grow in presence of the particular antibacterial drug.

The antibiotic penicillin acts on the growing cell only by inhibiting the cell-wall biosynthesis. In penicillin resistant mutant bacteria the resistance property is exhibited by a constitutive production of an enzyme penicillinase, which destroys the drug molecule after it has entered into the cell. In some instances of penicillin

machinery is altered (an effect of mutation in chromosomal gene in such a way that the antibiot cannot interact with the system.

Multiple drug resistance

By a chromosomal mutation sensitive bacterium may becom resistant to one drug in one ste But in case of enterobacteria the are many known examples of occu rence of multiple drug resista strains, i.e., their certain strains sho resistance against a number of ant bacterial drugs like sulphonamid chloramphenicol, streptomycin, tetr cycline, etc. Resistance to mar drugs at a time is not possible by single mutation in the chromosom Organisms' resistance to several drug chromosomal (if they are all linked) should arise only by th accumulation of mutations in succe sive steps. So, for selecting bacter resistant to, say, four differen antibiotics, chloramphenicol (C streptomycin (S), tetracycline (T and penicillin (P), four successive



"This time the bacteria have gone step further; they have befriende the new drug and both are livin happily together."

teps are necessary. It is therefore unisual that there would be a dramatic ncrease in the frequency of occurence of enterobacteria with multiple lrug resistance (MDR) in almost ill countries. In general, MDRs n those microorganisms do not seem o have arisen in a series of discrete teps but, rather, appear to have cen acquired simultaneously. Sonetic analyses have revealed that ADR is specified by an extrahromosomal (cyto-plasmic) genetic lement which is referred to as the rug-resistance factor or R-factor.

The R-factor was first detected n Japan in 1950s during an outreak of bacillary dysentery. Since extensive epidemiological hen, tudies have been carried out in apan, England, the Netherlands, witzerland and U.S.A. The studies ave shown that in numerous linical situations R-factors are the gents responsible for the resistance o different antibiotics and sulphonanides in enterobacteria. These ypes of MDR, controlled by Ractors, are also called infectious rug resistances or transmissible rug resistances because the genetic eterminant, the R-factor, can be ransferred from the resistant baceria to a sensitive strain of the different species; the ame or subsequently atter acquiring he drug resistance property. t affects a number of bacteria organisms ncluding responsible or dysentery, urinary infection, yphoid fever, cholera, and plague. ransmissible R-factors have also een detected in nonpathogens like coli. MDR factors have also cen identified in Staphylococcus ureus, but in this case the R-factors re non-transmissible in nature. It not known whether there is any enetic or evolutionary relationship etween the transmissible R-factors of enteric bacteria and the nonransmissible R-factors of Staphyococcus aureus (non-enteric), although resistances to many of the same drugs are involved in both.

The R-factors have been characterized to be small molecules of circular DNA having their existence as the cytoplasmic genetic elements. A different R-factor inherits a different combination of drug resistances. In case of bacillary dysentery the strain containing the R-factor has been shown resistance against four possess drugs: sulphonamide, tetracycline, chloramphenicol, and streptomycin. Certain drug resistant strains containing R-factor not only inherit the resistance properties against antibacterial drugs, they also inherit resistance against toxic metal ions like mercury, bismuth, arsenate, arsenite, etc. Staphylococcus aureus containing non-transmissible resistance factor PI has been shown to inherit resistance against penicillin, erythromycin, bismuth, arsenate, arsenite and mercury; while that containing non-transferable factor PII shows resistance against penicillin, erythromycin, and mercury. In case of chromosomal drug resistance the resistance property cannot be transferred to a sensitive strain unless it is done by a process of special genetic exchange in the normal life cycle which may be a rare phenomenon. But, if a bacterium in a particular population harbors infectious drug resistance factor the number of resistant bacteria in that population increases very rapidly. It is because the resistant bacterum can transfer its R-factor to a sensitive one which becomes resistant (R+). This process continues like a chain reaction and eventually a large number of bacteria (if not all) in that sensitive population become R+ within a relatively short time. T. Watanabe of Japan, who carried out an extensive study on this subject, suggested in 1963 that R-factors are composed of two genetically distinguishable units: a transfer



"It does not matter to me whether the bacteria loses to the drug or the dru loses to the bacteria as long as I do no lose to either."

factor (RTF) and a unit which harbours drug resistance génes (th r-determinant). The RTF is believe to mediate the autonomous repl cation of R-factors and to promot transfer from one bacterium t another by the process of conjuga tion. The r-determinants harbor genes which specify resistances t a wide range of common antibiotic and sulphur drugs. This hypothes has been verified by the recen finding that the RTF and the determinants can be dissociate from the R-factor under certai environmental conditions.

It has been mentioned earlier the in the case of chromosomal dru resistance the normal synthesis of biologically active macromolecule continues even in presence of a active drug which is recognized a an inert molecule by the altere machinery. But the drug resistance controlled by MDR factors is exh bited by different mechanisms. I most cases, the presence of the F factor DNA in the cell gives th extra benefit of having some enzyme which specifically inactivate th drug molecules either by structure modification or by catabolic destru on. Thus, the resistance to reptomycin, neomycin, kanamycin, ic., controlled by the R-factor, as been shown to be due to the resence of antibiotic modifying azymes in the resistant cell. The enicillin resistance is controlled y the synthesis of penicillinase by he resistance factor which degrades he drug molecule. Chlorampheniol resistance, controlled by R-factor, as been shown to be due to the resource of an enzyme in the resisant cells which causes modification f the drug to an inactive form by cetylation of the hydroxyl group(s) resent in the chloramphenicol nolecule. In case of tetracycline and ulphonamide resistances controled by R-factor the mechanism is bit different. These drugs can asily enter into the sensitive cells horeby reaching the intra-cellular ite of action. The resistant cells ontaining R-factor possess property by virtue of which they lo not allow the entry of the drugs nto the cell and so the drugs cannot each the intra-cellular site of their ction.

Drug redstances and their impact on seciety

Since the chance of occurrence of multiple resistant chromosomal mutants is rare in any population of bacteria, either pathogenic or non-pathogenic (unless those are purposely selected), they do not create any major problem for the human society. On the contrary, they have become a handy tool for the geneticists and the molecular biologists for studying life processes at the molecular level. But the emergence of infectious drug resistance is an unanticipated challenge to society. The occurrence of R-factor-containing strain is not restricted to the hospital outbreak only. R-factor bearing human pathogens are present in domestic animals and fishes, particularly where antibiotics are routinely used as diet additives. Of course, there is no reason to assume that the only danger to man lies in the communication of drug resistant pathogens like Salmonella, etc., from animals. By far the greater potential danger may come from non-pathogen,

E. coli, which is usually commun cated from animals to humans on large scale. These organisms frequer thy carry R-factor. Even if they d not survive in the intestine, the transfer their R-factor to the h man non-pathogenic enterobacter inhabiting the intestine. In the event of infection with the pathogen enterobacteria, the R-factor fro the non-pathogenic ones alread present in the intestine will be tran ferred to the former which w thus become R+ and hence resistar to the same set of antibacteri This poses a challeng to the treatment of infection b pathogenic enterobacteria by usir antibiotics, the ready-at-hand drug those R nowadays, because pathogens ignore the warning sign of more than one antibiotic. such a case, the only way to avoi this possible hazard is to culture th particular bacterial sample in the laboratory, taken from the paties concerned, and to test what type drug the bacteria show their sensit vity to. After knowing the proper dru the successful treatment will be eas

CHELATING AGENTS (Continued from page 594)

ices may be cleaned of heavy metal ontamination (radioactive) by hosing own with solutions of sequestering sents like EDTA.

Inschales

tive in ion control in small-to-moderate quantities in any industrial process. What prevents their fullest exploitation is the question of their economy. The synthetist must find ways of producing cheap chelating Chelating agents would be offec- agents that meet the specifications

of their intended use.

Further reading

Vogel, A.I., A Text Book of Quantitative Inorganic Analysis, Longman's Green & Co. Ltd., London (1961).



ECTODESMATA -THE NEW PLANT STRUCTURES

ctodesmata are threadlike structures in plant cells. They act s pathways for transport of nutrients

VIJAY K. SHARMA O.S. SINGH

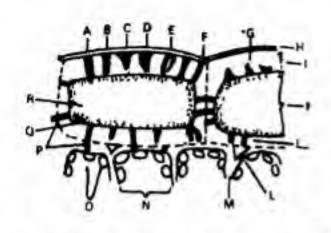
NTERCELLULAR connections in plant tissues are a prerequisite or their structural and functional Primary pit fields rganisations. hich are very thin portions in lant cell-wall are generally found on ne radial and inner tangential walls f epidermal cells of various plant rgans. Localization zones of very in protoplasmic strands at such oints in the cell-wall are called lasmodesmata. Cells of plant tissues re joined together by such rotoplasmic bridges (i.e., plasmoesmata) and transport of substances om cell to cell has been assumed to

be their function. It is a universally agreed fact that plasmodesmata are present only within the tissues and in the inner walls of epidermal cells and are absent in the outer walls of epidermal cells.

After a lapse of about six decades of the first description of plasmodesmata by E. Tangl of Germany in 1879, two German botanists—W. Schumachar and W. Halbsguth, in the year 1939 reported for the first time that the outer walls of epidermal cells of many plant leaves do develop thin places resembling primary pit field and plasmodesmata. Later,

they along with many other botanist confirmed these observations on th epidermal cells of many plants an named such plasmodesmata a "ectodesmata" in the year 195 because they, in contrast to plasmo desmata, do not communicate wit plasmatic strings of neighbouring cells but terminate on the surface of the outer epidermal cell-wall. Ecto desmata are fine structures in th outer walls of epidermal cells havin some analogy with plasmodesmata Because of their similar shape an localization within the outer wal they were first named "outer wa

r. Sharma is Lecturer in Botany; Dr. Singh is Associate Professor of Botany, College of Basic Sciences and Humanited unjab Agricultural Univ., Ludhiana



Pig. 1. Different types of ectodesmata and plasmodesmata in epidermal cells; A. ribbon like; B. broken into pieces; C. conical; D. wedge-like; E. filifform; F. ectodesmata appearing in the anticlinal walls; G. abbuformen; H. cuticle; I. outer walls; K. lumen; L. ectodesmata (because they border upon intercellular spaces); M. intercellular space; N. palisade cell; O. chloroplast; P. plasmodesmata in the isser wall; Q. nucleus; R. vacuole

plasmodesmata" and later as ectodesmata.

Wolfgang Franke of Bonn University, W.Germany, in 1961 described for the first time the structure and function of ectodesmata. According to him, ectodesmata seem to provide an almost direct connection of the protoplast with the surrounding outside medium of leaves. h may be emphasized, however, that ectodesmata do not extend to the guter leaf surface but are always covered by cuticle. They also provide continuation of the protoplasmic bodies of epidermal cells, projecting through the outer walls, to the cuticle. In 1969, W. Franke concluded that in the epidermal walls very fine aggregate spaces, the ectodesmata, exist which extend only in the walls and are covered by cuticle. Recently in 1971, Drs. E.L. Ervin and J. Sikkema of the Department of Biology, Hope College, Michigan (U.S.A.), have eported tubular projections extendng from individual epidermal ells into the cuticle in Smilax dspida stem. In this plant, the ctodesmata appear to be extensions f protoplasts into the cuticle which n rare occasions extend through he entire width of the cuticle.

Since ectodesmata are formed

like ordinary plasmodesmata, they generally have the appearance of ordinary plasmodesmata. In the leaves of Primula they often appear as fine strings. In Plantago major leaves they may be conical, wedge-shaped or even ribbon like (Fig.1). In the leaves of Helxine soleirolli and Chrysanthemum indicum a strange type of ectodesmata appear as pileate mushrooms. Its cap touches the protoplasmic body and the stalk adheres to the cuticle. Another strange type is paint-brush shaped. found in bulb scales of onion (Alltum cepa), the first leaves of Antirrhinum majus, and the leaves of Sidalcea neomexicana. Here, too, the broad part of ectodesmata is directed towards cell lumen and the stalk adheres to the cuticle.

Ectodesmata are generally short and project only to the middle of walls or reappear as if cut into small pieces. Even a day-night rhythm has been reported by W. Franke (1961) in a large number of ectodesmata during night and a small number during the day. Such observations have suggested that ectodesmata may be extended and retracted (by the protoplast) like the pseudopodia of an amoeba. But the recent researches indicate that ectodesmata exist in the walls all the time.

Plasmodesmata vs ectodesmata

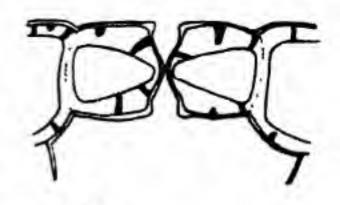
Although it was thought that ectodesmata should be homologous with plasmodesmata, direct proof of protoplasm in ectodesmata is lacking. Plasmodesmata have been shown to be cytoplasmic tubuli surrounded by plasmalemma and containing endoplasmic reticulum. This is not the case with ectodesmata. The structure of ectodesmata in the electron microscope appears to be thin strings which may or may not be related to interfibrillar spaces within the cellulose walls. Ectodesmata are not proper plasmatic threads within the wall, but merely interfibrillar spaces containing liquid excretion products

of the epidermal protoplasts.

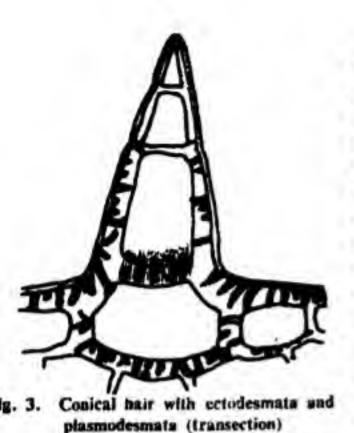
Ectodesmata may be demonstrate by a specific method using mercur chloride fixation and staining wit pyoctannin, a violet pigmen Presence of ectodesmata has bee demonstrated by means of electro microscope by using iodine-silve method and also with the polar microscope. zation By usin mercury-chloride method, plasmo desmata of the inner cell wall can als be made visible on the foot cells of th conical hair (Fig. 3) and the layer of epidermal and sub-epidermal cell beneath the larger leaf vein (Fig. 4) In these areas exists the whole system of pathways which connects th cells, starting from the cuticle and passing into the interior of the lea tissue.

Distribution

Ectodesmata are predominantly found in special sites such as along the anticlinal (radial) walls in some hair (conical hair) (Fig. 3), in the basal cells of hair, and in epiderma cells surrounding hair as in capitate hair. In contrast to conical hair the capitate hair contain no ecto desmata. A large number of ectodesmata are always found around them in epidermal cells surrounding their basal cells. While working or the outer epidermal walls of sensitive hair of Dionaea muscipula, in 1968 Andreas Sievers of Bonn University West Germany observed numerous radially-arranged fibrils approximately of 2 nm diameter penetrating the trigger hair of this plant. Most interesting is the abundance of ectodesmata in guard cells where



Mg. 2.



hey frequently show a typical istribution along the edges of stomaal pores and the rear walls of guard ells (Fig.2). However, they have of been observed on guard cells

f Smilax hispida stem.

Ectodesmata also appear accumulted above, beneath and on both ides of larger leaf veins in epidernal cells. In neighbouring cells ctodesmata may be less in number r even lacking. Ectodesmata, howver, have not been reported in eromorphic leaves due to the thick stomatous (i.e., without stomata) uticle which prevents foliar absorpon. In surface view the ectodesnata appear as points. Sometimes hey are lined up as rows of chains uite straight without regard to ell limits; in other cases they are rowded along the anticlinal walls. ctodesmata may encircle the cells f the conical hair. In epidermis, round these hairs they are frequenly arranged in circles which seem to ontinue the screw-formed chains round the basal cells of the hair. lso in guard cells of stomata he ectodesmata accumulate partly long the convex walls and partly long the concave walls bordering he pores themselves, sometimes, lowever crowding only on the poles of the stomatal pores.

Functions

W. Franke (1967) described actodesmata as thread-like structures

with the role of pathways for wall penetration and demonstrated that foliar absorption and excretion of substances are confined to ectodesmata. Ectodesmata serve as pathways for transport of substances from the outside to the interior of the tissue and vice Since leaf-surface such as stomata and hydathodes are not the primary pathways for salt absorption and absorption by pectic layers is questionable, the only possibility then is through outer walls from the cuticle into the protoplasm of the epidermal cells.

The occurrence of ectodesmata in the outer walls of epidermal cells may explain many observed facts pertaining to foliar absorption of diverse substances. The phenomenon of excretion may also be explained. Thus ectodesmata are supposed to be involved in foliar penetration and as pathways for substances that are discharged through the cuticle. While working on ectodesmata in relation to binding sites for inorganic ions and urea on isolated

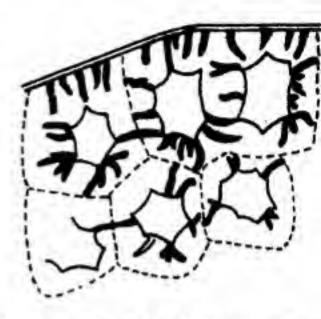


Fig. 4. Ectodesmata and plasmodesmata a epidermal and subepidermal cell beneath a vein of Plantago leaf (transection)(Figs. 1-4 after Franke, 196.

Franke in 1969 concluded the in intact epidermal cells the bindin sites in the cuticle lie on the to of ectodesmatal spaces in the wa and that together they form combine pathways of favoured penetrabilit for aqueous solution which is to be absorbed or excreted. Drs. F.M. Scott, K.C. Hamner, E. Baker and E. Bowle of University of California in 1958 proposed the (Continued on page 623)

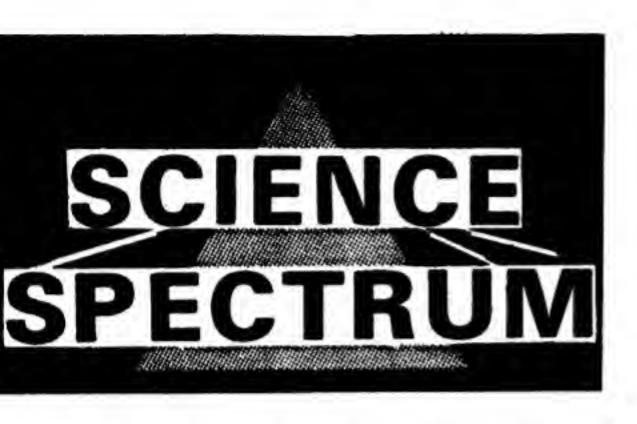
A CONTRACTOR OF THE PROPERTY O

Fig. 5. Simplified scheme of the outer wall of an epidermal cell showing the ectodesmat.

A. Wax coating; B. Cuticle proper; C. Pectic layer (cuticular layer); I. Primary wall; E. Secondary wall; F. Plasma membrane; G. Cytopham; I. Ectodesmata as nonplasmatic structure; I. Wax droplets (after Franke, 1967)

SCIENCE REPORTE

A with a Mile



X-rays from supernova remnants

A N incidence of explosion in the heaven, millions of times more cowerful than a nuclear explosion, is the birth of a supernova remnant. It is one of the rare events that istronomers always eagerly await for. The entire panorama of the tar-studded sky then looks dim and trab in the supernova's presence.

The frequency of occurrence of a supernova is as small as once in a ew hundred years. It is still more educed for us on earth, as usually en out of eleven supernovae occur inder the cover of dust clouds. So ar, astronomers have been able o witness only three supernovae vents whose frequency of occurrence s quite erratic. The first is the Crab Nebula, presently the most fascinatng object in the heaven, discovered y the Chinese in 1054 A.D. The second is the Tycho's nova, disovered by the great astronomer ycho Brahe in 1572. The third as discovered in 1604 by Johannes epler, renowned for his planetary ws of motion.

The inert matter that the supernoval arows off is called supernoval remant. After the explosion the immant travels through the intercellar space and interacts with it reating a number of startling pheno-

mena. One of the recent discoveries is that the remnants emit X-rays (Scientific American, Dec., 1975). As the production of X-rays needs very high energy, it is strange how these remnants which are almost like the garbage thrown off one's house could produce them. Since then many theories have come up. Before details of the theories are discussed, something about how a supernova explosion takes place needs mention. Supernova explosion

How a supernova explosion takes place is a long story covering nearly 100,000 years to 100 million years—from the birth of a star to its doom, when it becomes a supernova.

A star is born when particles in a nebulae are gravitationally attracted to coalesce, and the process continues. As the matter goes on piling on the surface of the newborn star, two forces come into play and on these two forces only depends the evolutionary path the star would take. Gravity is one of the forces. With the onfall of mass the gravity becomes strong and so compresses the star. But for the other force, which is in fact a result of compression, the star would have collapsed in the initial stages. Compression

produces heat inside the star an starts a chain of thermonuclear n actions. The phase is called nucleo synthesis. At a very high tempera ture hydrogen, which is present i abundance, transmutes itself int helium. The reaction being exother mic, i.e., heat releasing, expand the star, checking the collapse pro duced by gravity. As soon as the entistar transforms itself into helius the reaction stops and, again, con pression by gravity begins. The ten perature produced as a result reach high enough to transmute helium in to carbon. The reaction is exothe mic, so, again the collapse is checked In the similar manner carbon ge transmuted into heavier element Henceforth, the fate of the star hang on its mass. If its mass is less tha that of the sun, it would slowly evolv and become a white dwarf ultimate -a star having an incompressib core composed of tightly-packed eletrons. On the other hand, if the man of the star is several times that of th sun, the huge amount of heat produc ed as a result of transmutation would evolve it speedily, and lea violently to a supernova explosion It throws away about 90 per cer of its mass in the surrounding in terstellar space.

Whatever remains of the star as mostly heavier elements. Because of the compression produced as a resul of gravity, the inside of the star start getting hotter. The subsequent trans mutations take place. However, a the reactions are endothermic, i.e. heat absorbing, a cooling effect is also produced. Moreover, then remains no force to arrest the gravita tional collapse. Depending upon the mass, the star either continues to live as a small normal star or a neu tron star or a black hole. In either o the latter cases, the core of the sta is compressed into a superdense state where electrons and protons no longer remain as individual enti ties; the entire matter becomes com posed of neutrons, and the star is called a neutron star. It has a ensity equal to that of atomic ucleus, about 10¹⁸ gm/cc. If the eutron star is comparatively massive, he gravitational collapse continues nexorably, eventually forming a lack hole, nearly 20 km in diameter. It a black hole, the gravity is a strong that it does not allow even ght to escape.

That the astronomy can be divided

rab Nebula

ito two portions, one the Crab lebula and the other the rest of ne universe, as claimed by Geoffray urbidge, a distinguished physicist, ems aptly correct. The Crab lebula is a mystery to us, mostly ecause the energy it is radiating t a titantic scale is far higher nan released by any of the younger pernova remnants. Additionally, radiates over a wide range of wavengths from radio waves through sible light to X-rays. Structurally lso, it is different from the younger nes. The sole reason attributed to Il this is the presence of a singular owerhouse, a pulsar, in the nebula. xactly how the pulsar interacts with ne nebula to produce all kinds of ediation in large amounts is not ear. Some of the ideas that have een put forth, however, look cogent. The pulsar embedded in the neula is a spinning neutron star hich has retained the angular nomentum of the non-nal pre-exloded star. Strong magnetic field which juts out of its surface also pins with it. As electrons are jected by the pulsar, they traverse he magnetic lines of force spiralling ll along the way. In this manner lectrons get accelerated to relativisic speeds and radiate effusively ver a wide range of wavelengths. he radiation so emitted is called ynchrotron. The pulsar, it has been bserved, spins about once every 0.033 econd and is gradually slowing down, t nearly 3.510 sec/revolution/day.

Accordingly, the amount of energy it dissipates has been calculated. It has been for nd to be equivalent to the energy lost by the entire Crab Nebula. This justifies the assumption that pulsar is the sole source of radiation.

Had there been a small region about the pulsar radiating in the manner aforementioned, the above explanation would have 'sufficed. However, there does seem to be some other processes involved as the entire supernova remnant, spanning an area of millions of square kilometers, emits synchrotron radiation. The energy from the powerhouse, it seems, is being transmitted to every nook and corner of the nebula. What can be its mode of transportation? The answer is through magnetohydrodynamic shock waves; a kind of waves that travel along the magnetic lines of force through an electrically conducting fluid. The nebula, it is claimed, contains ionised gases and the shock waves are generated by the neutron star. The shock waves, as they travel through the nebula, are damped by the gaseous material to extract energy. Having gained more energy, the already high energy electrons and protons present in the nebula produce synchrotron radiation by spiralling through the extended magnetic fields in the nebula.

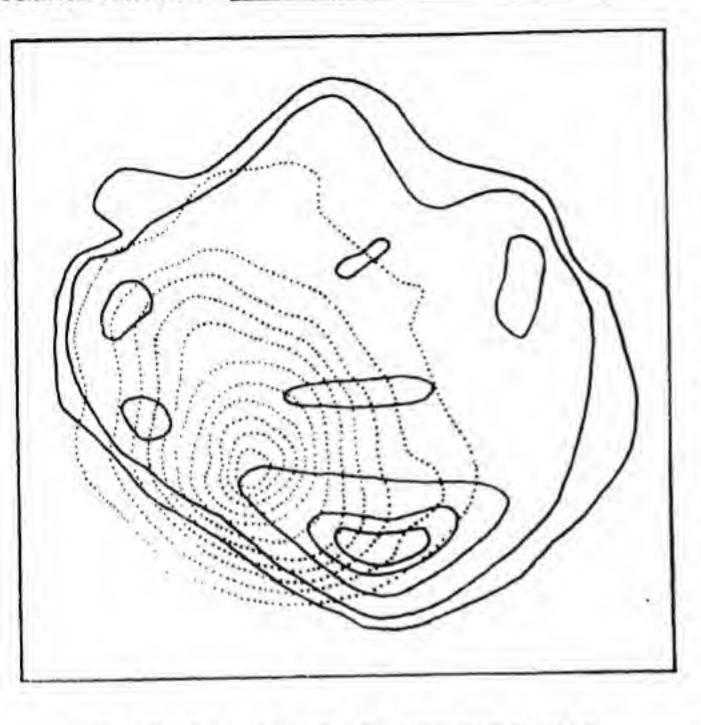
This theory, put forth by Aaron Barnes of NASA and Jeffrey D. Scargle of Lick Observatory, holds good for radiation over all wavelengths, even X-rays. Although very powerful telescopes to map the nebula, point-to-point, have yet to be built, a study carried out by the lunar occultation of the nebula has revealed some startling details. There is a spherical region in the nebula which generates and radiates X-rays, but whose centre is displaced from the position of the pulsar by about 10 seconds of arc. Further, areas which emit higher energy X-

rays coincide with the visible wisp present in the nebula. It has bee analysed that these regions somehor further accelerate the high energ electrons emitted by the pulsar t emit not only high energy X-ray but also visible light.

Cassiopeia and Tycho's novae

These two supernova remnant have similar structures in th radio spectrum. "Knots"-- chaos o masses-have been seen in them In fact, in the initial stages whe Cas A was being studied astronomer were baffled by its behaviour. Two types of component in the radio re gion of Cas A have latter been found one that always remains stationar and the other that moves very fast The latter becomes unrecognisable i its features within months! The chao and turbulence these motions seen to suggest became clear when Stever Gull of the University of Cambridg gave a cogent explanation. He said that some components were stopped due to their interaction with th interstellar matter. He elucidates "behind the scene" story a the follows.

When a supernova explosion take place, it kicks off a dense shell o gas from the centre, the star. The shell expands and interacts with the low density interstellar gas tha comes in its path. As a result, the shell sweeps in the gas and become heavy. Consequently the speed with which it was kicked off gradually decreases. Within a period of 100 years, it is estimated, it sweeps in a much mass as the original explosion threw away. As the outer layer o the shell goes on mopping up mas it clears way, an empty space, for the subsequent layers to travel through unhindered. So, the inner layer go on at their initial speeds and eventually strike the outer, slow moving layers in the back, creating shock waves and heating the inter



X-ray (dotted contour) and radio (black contour) maps of Puppis A

stellar gas ahead of the shell. The shell too gets heated up, and when it encounters the gas ahead the entire intervening layers become unstable, crack up to form filaments which are observed as "knots". As the Cas A is also a strong X-ray source, efforts are on to look for any features in this spectrum that correlate with the knots observed in the radio spectrum. Till now astronomers have been unsuccessful in doing so for want of high resolution telescopes. However, a crude comparison between the X-ray and the radio map of Cas A suggests that X-rays are generated not by synchrotron process, but by two volumes of gases at different temperatures. An empirical proof for this assertion has been given by Alan N. Bunner and coworkers at University of Wisconsin after studying the Tycho's nova. Researches are presently in progress to improve

upon the X-ray resolution techniques so that the emission lines exhibited by two gases at different temperatures could be resolved.

Old supernova remnants

It is known that as the outer shell of a supernova expands it grabs mass from the interstellar space. At the end of its evolution, it sweeps up mass much larger than it had initially thrown off into space. The mass gathering naturally reduces the shell's temperature. The temperature behind the first shock waves drops to less than 10 million degrees K. In such a state, there is no doubt that the temperature is not high enough to produce X-rays. Nevertheless, it is possible that synchrotron process produces it, for there may still be some electrons trapped in the interstellar magnetic fields that were compressed by shock waves. And

in case if the electrons are unable to produce X-rays, they can still produce lower energy radio waves by the same process.

The old supernova remnants are those which are on the verge of oblivion. Their material has been distributed over such a large space that it has density almost above that of interstellar space. That is why they are called extended radio sources as they emit radio waves. Only recently, due to the studies of Frederick D. Seward and colleagues of the University of California, these extended sources have been found to be emitting X-rays also.

One of the oldest supernova remnants is Cygnus Loop, some 20,000 years old. Its diameter is more than 1000 light-years. Although there is no trace of the material it had ejected, it emits X-rays scattered nonuniformly all over. According to Gordon P. Garmire, C.I.T., U.S.A., the reason for this is as follows: Whenever a shock wave encounters a dense cloud, a thin, hot shell of gas is produced. As observed spectroscopically, the velocity of the shock waves is low but it is enough to produce X-rays from the cloud. So wherever the gas density is uniform or low, no X-rays are produced; or if they are, then they are weak.

Puppis A is similar in nature. A comparison of its radio and X-ray spectrum tells that its bright X-ray regions do not coincide with those if bright radio. It is analysed that the X-ray emission arises as a result of interaction between an expanding shock wave and an interstellar cloud. Wherever the shock waves and X-ray region do not appear to coincide, the temperature is not high enough to produce X-rays. Still another example of non-uniform X-ray emission is the old supernova remnant IC443. As there are intense knots of filaments at the centre of the supernova, it is believed that ther there is a dense interstellar oud in that region, or that region as not lost much of the explosive orce of the supernova. Why study ray emission from supernova remants? It is to know about interstellar space. As the supernova emnants interact with interstellar pace over great distances from the upernova, the X-rays produced

would enable us to know its density and relative abundance of elements. The mysterious phenomena at play in the Crab Nebula and other objects could also be analysed. The knowledge gained, particularly about energy production, may help us in solving the energy crisis on this planet.

DILIP M. SALWI

High coersive force magnets

OERCIVITY is one of the most important characteristics of ermanent magnets. It is defined as measure of the ability of the magnet retain its magnetic properties in dverse magnetic fields. Magnets nade of steel have a coercive field alue of nearly 250 oersteds, which ssentially means that magnetization tensity in magnets of this type emains practically stable at opposng magnetic fields of the order of 50 oersteds. Attempts have been nade since the early 20th century o improve upon these coercivity alues for permanent magnets. Alnio type magnets developed in 930's had coercivity values of the rder of 500-600 oersteds.

High coercive force (HCF) magnets the name given to a group of nagnets that have the ability to reain a useful level of mangetization n demagnetizing, fields which are nuch larger and even approach or xceed the residual induction of the nagnets. Magnets of this type inlude the barium and strontium errites, platinum-cobalt alloy and the are earth cobalts of the composiion RCo, where R is one or a combination of the rare earth elenents such as Sm, Pr, Nd, Ce and Y. The coercive force values of this latter group are as high as 30,000

of this type after casting, the alloy is ground, pressed into the desired shape and densified by sintering or high pressure.

There has been a great interest in the study of HCF magnets because of the numerous uses they can be put to. The magnets used in loudspeakers, microphones, magnetron, etc., usually operate at low values of the demagnetizing fields. However, sometimes it is necessary to alter the magnetic circuit for system maintenance in such a way that the magnet is exposed to demagnetizing fields greater than the normal operating fields. The reassembled device, therefore, has a lower operating flux if the magnets are made of steel or are of Alnico type materials. An HCF manget installed in such a device will operate it at its full efficiency. HCF magnets are also desirable in high power microwave devices which include a large variety of components used in radar and communication systems. Their stable magnetization increases the reliability of permanent magnet rotating machines, increases the available torque, and allows reduction in inertia through allowed rotor dimension and mass reduction. They have also been used in battery-operated wrist watches, magnet systems and motors used in air and space craft.

HCF magnets are highly favoured potential candidates for use in permanent magnet suspension systems, for high speed ground transportation systems are likely to come up in the near future. These systems are capable of providing speeds of the order of 480 kmph. Permanent magnet bearings have a large scope of applications and are much more desirable than conventional mechanical bearings in some systems. Many bearing-supported parts are employed, for example, in satellites, which are crucial to their mission and life Permanent magnet bearings using HCF magnets, it is hoped, will do away with the problems encounter ed in using mechanical bearings and increase systems life time consider ably.

> B.L. ARORA Deptt. of Physic A.R.S.D. College New Delhi-11002

Climate and clothing

THE condition of a country or a place with regard to temperature, moisture, topography, vegetation, etc., is known as the climate of that particular region.

Men and animals living in differer climates adapt themselves to the climatic conditions of the place Man, being mobile, moves from or climate to another. There are also seasonal changes in the climate of a place. Adaptability of men and animals to climatic changes is a prerequisite to lead a comfortable life. So a climatologist studies the relationship between the climate and the human habits.

Clothing, one of our important needs, plays two major roles. First, it protects the wearer from adverse environmental conditions; secondly, it covers the body. Obviously, the first role is more significant.

Clothing interferes with the heat exchange or heat balance between man and his environment. The heat exchange may be in the form of radiation, conduction, convection or evaporation. All bodies radiate heat. The sun radiates energy in the form of short waves because of its high temperature of 6000 K. The earth and other objects on the earth which receive solar radiation reradiate it in the form of long waves because of their low temperature.

The radiation balance between man and his environment may be given as:

R=I_N K_{po} K_{o1} [1-a (V^{0.3}-0.88)]

where R-solar radiation Kgcal/hr,

I_N=normal solar intensity,

Kpe-coefficient that varies with topographical characteristics and posture. For example, the value for an individual sitting his back to the sun, in the desert, is 0.386 and while in forest it is 0.379. Similarly, while standing in desert it is 0.306 and in forest it is 0.266,

Keta = clothing coefficients where Ket = 1.0 for semi-nude individual,

=0.5 for one clothed in light summer clothes,

imilarly, a=0.35 for semi-nude,

=0.52 for light summer clothed individual

V-wind speed in metres/sec. From the above expression, it is lear that clothing interferes with the his environment. Also, clothing interferes with the penetration of incident short wave radiation; only 5% of the total incident radiation penetrates through a single-clothed layer. It is found that light-colored fabrics have higher albedo (i.e., higher reflectivity) than dark-colored ones. So, it is advisable to wear light-colored fabrics in summer in tropical regions where the sun is very hot.

In their paper Clothing for desert:

A preliminary assessment of olive green and khaki colored uniform for desert, S. Kundu and K.V. Mani of the Defence Laboratory, Jodhpur, in 1962, claimed that from the aspects of thermal protection and camouflage against terrains of various shades, 'khaki' uniform gives much better result than the 'olive green'.

Clothing provides a thermal insulation over the body. The insulative value of different layers of clothes is additive. To elaborate this concept of thermal insulation, a unit known as 'clo' is used. A 'clo' unit is equivalent to the insulating value of a clothing layer which permits 1 kg cal/m²/ hr of heat flow with a temperature difference of 0.18°C across the clothing layer. Roughly, one 'clo' unit may correspond to the amount of insulation provided by an ordinary woollen suit.

Using 'clo' unit the heat conduction from the body is expressed as

$$H=5.55 \frac{(t_0-t_0)}{I_0+I_{01}}$$

where H=rate of heat loss Kg cal/ cm³/hr

t_a and t_a = skin and ambient temperatures in °C respectively,

I. = Thermal resistivity of ambient air and clothing which varies as the inverse square root of wind speed,

In = 'clo' unit.



"I do not change clothes to suit new climate. I simply change to new climate to suit my clothes."

Clothing clearly interferes with the loss of heat by conduction provide the air movement between the clothing layer and the skin is eliminated. That is why it is a common experience that two clothing layer give more warmth in winter. The air between the two layers is still and the body heat is conserved by eliminating heat loss by convection.

Another important factor which contributes to heat balance between man and his environment is 'evaporation', the process by which liquiwater is converted into water vapous causing a rapid cooling of the body

The rate of cooling by evaporation (in the presence of clothing) is determined by the humidity or vapour pressure and the resistance of the clothing assembly. Evaporation from the body surface can be expressed as:

$$E_0 = K_{ee} \left(\frac{(P_0 - P_0)}{ra + rc_1} \right) W$$

where E == evaporation loss from body surface kg cal/cm²/hr

Kes-constant (approximately 5)

Ps and Ps—vapour pressures at skin surface temperature and air



"It is time scientists learn to make weather adapt itself to our clothes."

emperature respectively in mm of nercury.

rand rc₁=resistivity of ambient air and clothing respectively, W = proportional wetness of skin (varies from 0.05 to 1.0).

The introduction of clothing inerferes with the rate of cooling by
evaporation. It first reduces the wind
ffect and then lessens the evaporation
oss. The cloth absorbs moisture
from the skin and the moisture from
the cloth evaporates and decreases
the cloth temperature. No doubt,
the cooling of the cloth will affect
the body temperature but it is not as
effective as direct evaporation from
the skin.

Studies have been made to find out the insulating value of different fabrics. It has been found that fabrics such as wool, fur and some types of cotton give an insulating value of 4 clo units per 25 mm of thickness. It is observed that warmth of different degrees is felt with different fabrics of the same thickness. This difference is due to air movement through the fabrics. Cotton fabric is a good windbreaker in breezy conditions and provides better insulation than a woollen sweater. Woollen sweater would be a good insulator in still air. Effectiveness of a clothing insulation decreases for smaller parts of the body. For smaller parts, like fingers and feet, higher insulation is required to keep them as warm as the other parts.

It is of interest to a climatologist to find out the clothing requirements of a man in different seasons and in different climatic zones. Once the clothing requirements for different climatic zones are known, it is easy to study the palaeoclimate (climate of a region in the past) of a climatic zone, provided the clothing habit of that particular time is known.

A.S.R.A.S. SASTRI Climatology Section Central Arid Zone Research Institute Jodhpur-342001

pressure gradient force, tidal curren generated by the gravitational force etc. In addition to these group which may occur anywhere in a larg area of water body, there are certain currents found only along the se coasts in the break zone. Thes are the longshore currents and th rip currents generated by the ocean waves when they break near th coasts. Among these two, the rig currents require special mention because they carry a lot of beach material towards the sea and are very dangerous to the swimmer on the beach.

Rip currents are common along gently sloping sandy beaches. They are very strong and flow towards the sea away from the beach. Near the coast they are very narrow and widen as they flow away from the shore. It may be observed that near the shore the width of the rip is about 15 to 30 metres and it attains a width of about 30 to 130 metres away from the coast. These figures, however, are not typical because normally the rips are much narrower. The length of the rip currents varies depending upon the in coming waves. For a given beach slope, the length tends to be shorter when the waves are small.

The rips might be as long as 1.5 km to 3 km when the sea is relatively rough. Regarding the speed of the rips there are few observations, but they can attain a speed of about 2 to 3 knots under certain conditions. The speed decreases in the direction of flow. More precisely, the maximum velocity of the rip current decreases inversely with the distance from the coast, and the half width increases linearly with the distance. The region, where there is an abrupt expansion of the width of the rip current and a rapid decrease of the

Rip current—swimmer's enemy on beach

A NY flow of water may generally be called a current and, deending on the force that generates them, we can group them as wind currents generated by the wind, geostrophic currents triggered by

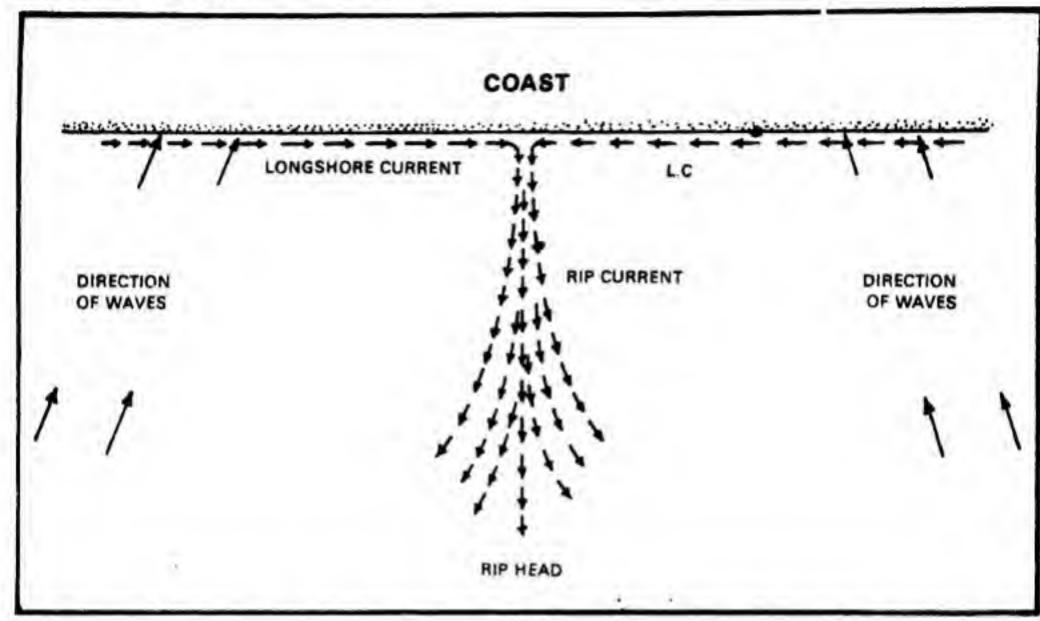
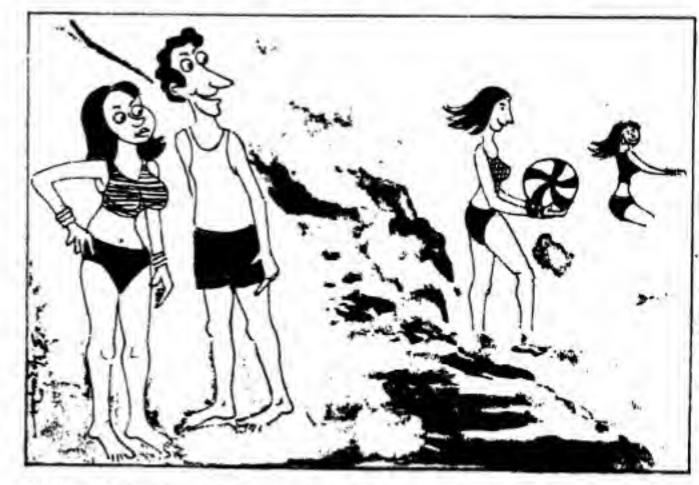


Fig. 1

speed, is called a rip head. Beyond the rip head, the current mixes with surroundings and loses its identity. The rip currents normally flow perpendicular to the shore line. But this need not always be the case. Many of them run obliquely across surf zone, and as the rips tend to turn away from the direction of approach of the waves, they may not always follow a straight course. There seems to be some sort of regularity in the spacing of the rips on the same stretch of a beach and they are generally noticed where the wave activity is less than in the neighbouring areas.

The mechanism by which the rips are generated is simple. When waves break, the wave energy is released on beach. Depending upon the angle he wave crests make with the shoreine, the forces generated by this nergy can be resolved into two irections—one perpendicular to the hore and the other along the shore.

The perpendicular component of the force is responsible for stirring up the beach material, while the alongshore component generates a current in the direction known as the alongshore current. Since the distribution of wave heights along a lor stretch of coast is not uniform an the waves strike the coast with differ ent angles, there may be zones of convergence and divergence of wave energy at different parts of the coast



"Not only are currents dangerous to swimmers, my dear, even the curves on the beach are so."

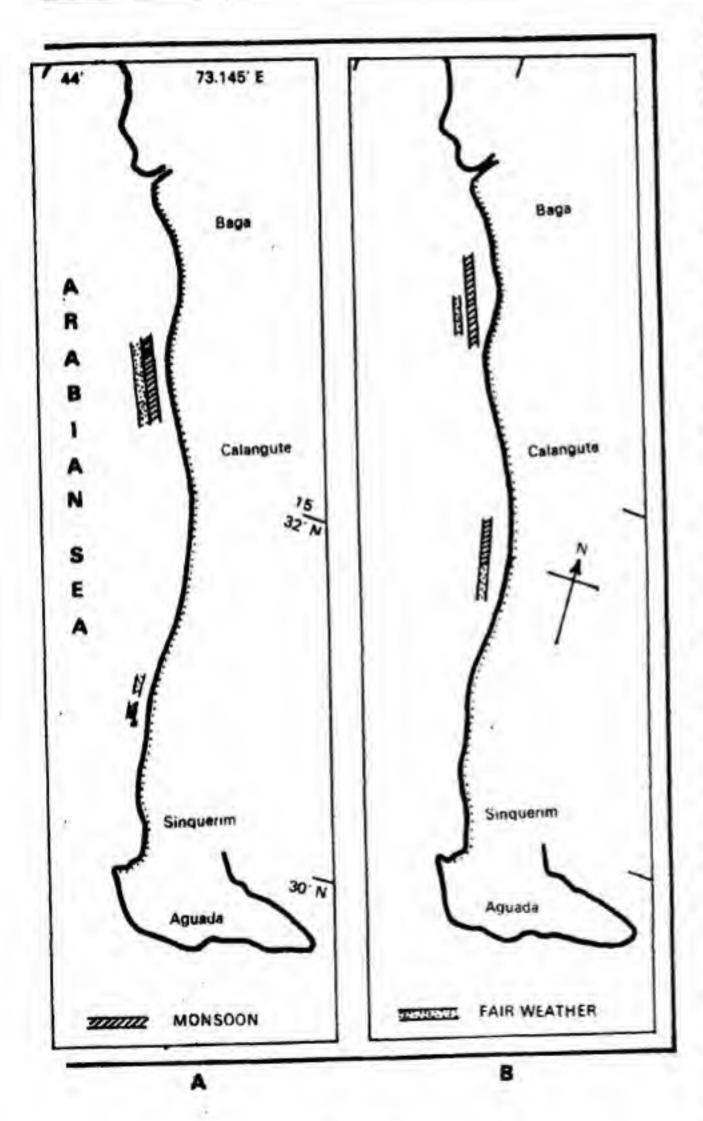


Fig. 2

and the longshore currents may flow in opposite directions. These oppositely flowing longshore currents meet at certain places and at these places the two currents merge together and flow away from the shore towards the seases rip currents (Fig.1). Though generally the rip currents are generated in this way, it is not always necessary that two longshore currents should meet to generate a rip current. In certain cases, when the angle of approach of the wave is sufficiently acute, a

strong longshore current will be generated and this current may turn obliquely towards the sea to form a rip current.

Rip current is the biggest enemy of a swimmer in coastal waters. Most deaths by drowning in the sea occur as the victims are swept away by the rips. A swimmer caught up in a rip is most likely to be carried away. The human tendency such situations is to try to swim against the current. As a result the swimmer gets exhausted and drowned eventually. Once caught up in a rip, it is advisable to swim across the current and, as the current is very narrow, one can be out of it soon. The tendency to choose a comparatively calm region for swimming may also prove dangerous because, as mentioned earlier, the rips generally originate in calm regions.

Rip currents play an important role in the beach processes such as beach erosion, accretion, etc. When waves break, a part of the energy released keeps a part of the beach material in suspension and this suspended material is carried alongshore by the longshore currents. But it is the rip currents that carry such suspended material offshore resulting in a loss of material from the beach. It also forms a part of the circulation pattern in the breaker zone.

The rip currents along a particular beach can be demarcated either from field observations by throwing certain types of dyes or from theoretical studies like constructing wave refraction diagrams. For a given beach the constancy of the areas of rip currents depends on the direction of wave approach. As the direction of the predominant waves is not likely to vary much within a particular season, the areas of rip currents along a beach for different seasons can be demarcated with a certain amount of accuracy. It is, therefore, obvious that intensive studies or the nature and genesis of rip currents will help considerably in determining the movement of beach sediments along a coast and would significantly reduce the number of deaths by drowning in the sea.

Rip currents along Indian coasts

Information on rip currents along Indian coastline is meagre as only a few attempts have been made so far to study them. The only study perhaps may be the one carried out recently along the Goa coast where the rips were studied extensively (Fig. 2). This 7.5 km long straight strip of sandy beach includes the famous Calangute beach, one of the important tourist attractions in our country. Frequent deaths by drowning in the area and erosion during monsoon have created problems for he local authorities. Studies were, herefore, initiated by the National

Institute of Oceanography, Goa to understand the direction of movement of beach material and the areas of rip currents dangerous to swimmers during fair weather (October-May) and monsoon (June-September). The study has revealed a number of areas of rip currents along the beach. The areas of persistent rips are shown in Fig. (2 a).

In order to promote tourism, Government of India and the local authorities have recently framed a number of developmental programmes to improve facilities for tourists beaches. Nevertheless, On our information on rip currents is not available in respect of many of our beaches. It is high time to give serious thought to this problem.

> M.K. ANTONY National Institute of Oreanography Goa

instruments such as motion pictu cameras and electronic pupillomet to measure pupil's size.

He and his team used sophisticate

Hard, soft ... eyes!

In an experiment Hess showed tw photographs of a young attractive woman to a group of men and aske them to describe her. The picture were identical except that in one th pupils were large and in the other small. The subjects, without notice ing the difference in pupil size, der cribed the photograph with larg pupils as "soft", "more faminine" of "pretty". The picture with sma pupils was described as "hard' "selfish" or "cold".

An eye wash preparation contain ing atropine—a pupil dilating chem cal-was in use in the United State until it was curbed by the U.S. Foo and Drug Administration. Evident ly, the enlarged pupils make eye more attractive. Why do we fin children's eyes more loving, attrac tive or bright? It is because the have in addition to other physics characteristics larger pupils tha adults.

Eye-to-eye communication

WE often describe eyes of others as soft, hard, cold or warm. What do these adjectives mean in elation to eye? Is it correct, as is commonly believed, that eyes can express emotions? Ten years ago, rofessor Eckhard H. Hess of the University of Chicago described that when viewing a pleasurable object, he viewer's pupils are dilated and the ize of pupils is related to his emoions and mental activity. Recently, less has been interested in the role f pupil size in non-verbal communiation, i.e., how emotions could be xpressed by changes in pupil size. lis findings (Scientific American, lovember, 1975) have revealed how ome one's pupil size affects the ttitude and responses of the person,

who observes them, at an unconscious level. We all encounter many instances in our day to day life: somebody who is confident while talking looks straight into your eyes and another, shy in nature, averts his eyes.

Pupils: eyes windows

Pupil acts to regulate the entrance of light rays. In darkness pupils dilate to allow enough light to pass and focus on the photosensitive layer, the retina. The reverse happens in light: the pupils contract to prevent excessive light from entering into the Pupillometrics-the measureeye. ment of changes in pupil size—as Hess has named it, is a useful tool in the study of changes in attitudes.

Pupil size and sex

Large pupils in a woman are a indication of her sexual inclination When viewing the larger pupils of woman, a man's pupils too dilat meaning a change in his response to the female's attitude.

A psychologist, Thomas M. S Simms, at the University of Toronto studied the pupil responses of norma married men and women. The subjects were shown two photographs each of a man and a woman, one with small pupils and the other with large pupils. The researcher found some interesting results:

(i) the pupils of male subject viewing woman's photo graphs with large pupils were dilated most.

- (ii) the pupils of female subjects viewing man's photograph with dilated pupils were also dilated most.
- (iii) the response to small pupils by the opposite sex was insignificant: the pupils in opposite sex were not much dilated.
- (iv) The pupil responses of men to both the photographs of man were almost nil. But women's pupil response to large pupils in woman's photographs was typical. That is, their pupils were contracted most than they did to the woman's photograph with small pupils.

These findings have been supported y studies of other researchers as ell. Investigating homosexuals, imms found further evidence of the ole of pupil size in sexual communication. His findings are that the sale homosexuals have no effect on

their pupil size by viewing the dilated pupils in a woman's photograph, perhaps because they find no appeal for this signal of sexual interest in women.

Pupils as "releaser"

Any stimulus that releases pattern of behaviour is a "releaser". So, Hess wondered if large pupils in children did not act as a "releaser". along with other factors such as their physical characteristics, to release the caring response in adults. Janet B. Ashear of the University of Chicago investigated the effect of her pupil size on infants. She found that after artificially dilating her pupils with phenylphrine hydrochloride provoked more smiles in infants of 90 days to 105 days. Her result suggests that positive response in infants to large pupils may be a part of infant's perceptual development, i.e., development of the ability to perceive environmental stimuli.

ZAKA IMAM

Hard and soft acid and bases

DEFORE the Arrhenius theory of electrolytic dissociation came nto existence the properties of acids ere known, viz., they were sour in aste and gave effervescence with arbonates. According to Arrhenius heory, acids are those species which issociate into hydrogen ions, and ases, into hydroxyl ions. T.M. owry (England) and J.N. Bronsted Denmark) gave protonic definitions hich were not limited to any redium. According to them, an cid is a species that tends to give up proton, and a base is a species that ends to accept a proton.

The American scientist G.N. Lewis, 1923, extended the idea of acidase reactions and published yet another definition in terms of donation and acceptance of a pair of electrons. Lewis concept defines an acid as a unit that is capable of accepting a pair of electrons and a base as a unit which is capable of donating a pair of electrons. A general acid-base reaction is

A + :B = A:B .. (1)

'A' is an acid and ':B' is a base which
has at least one pair of unshared
electrons. For example, in the
simplest ionic reaction

H+ + OH-= H-OH .. (2)
H+ is capable of accepting a pair
of electrons and OH-has one electron
pair to donate, the neutralization can
be explained in terms of the formation
of a covalent bond H-OH. The equa-

tion (1) can be used in understanding the acid-hase reactions, oxidationreduction reaction, metal-ligand complex formation and nucleophilic substitution reactions. In metalligand complex formation, 'A' will be a metal with vacant orbitals and ':B' will be a ligand with a donor atom which has a pair of unshared electrons. 'A:B' thus will be a metalligand complex, i.e., a coordination compound. The nucleophilic substitution reactions can be easily understood if ':B' is considered to be a nucleophile. Any species molecular or free radical, which has a donor atom having at least one pair of unshared electrons is known as Lewis base, e.g., H.O, OH-, F-, I, etc. Similarly Lewis acid is a species which has an acceptor atom having vacant orbitals to accept electron pair. Thus H+, Li+, Be++, Mn++, Al+++, I+, etc., are Lewis acids. Though the Lewis concept has a wide scope of applicability, it has some weaknesses as the idea is not directly applicable to the protonic acids and moreover when the question of relative strengths of acids and bases comes, it fails to give quantitatively the relative strength of acids and bases.

In 1963, Ralph G. Pearson (Illinios, U.S.A.) proposed a new concept which is known as 'Hard and Soft Acid and Base concept' (HSAB in short). According to Pearson, all Lewis acids and all Lewis bases can be classified into two categorieshard and soft. Soft acids are those which have acceptor atoms large in size, of low positive charge and containing unshared pair of electrons (p or d electrons) in their valence shell, i.e., they have high polarizability and low electronegativity. Polarizability is a measure of ease with which an atom can accept or share the electrons. According to Pearson. this property can be used as a measure of softness of acids or bases. Hard acids are those in which acceptor stoms are small in size, of high electronegativity and low polarizability. Cu++, Ag+, Au+, I+, etc., are soft acids and H+, Li+, Be++, Sr++, Al+++, etc., are hard acids. Similarly, a hard base is one which has donor atoms of high electronegativity and low polarizability. A soft base is of low electronegativity and of high polarizability. For example F, CH, COO, PO, ---, CI-, etc., are hard bases and I-, SO, --, CN-, CO, etc., are soft bases. Hard base is hard to oxidize and soft base is easy to oxidize. Hard bases hold on their electrons tightly and soft bases hold their valence electrons loosely.

The principle on which the acidbase reactions can be discussed is that "Hard acids prefer to coordinate with hard bases and soft acids prefer to coordinate with soft bases." It has been found experimentally that soft acids combine with soft bases and hard acids with hard bases. This is known as principle of 'Hard and soft acids and bases.'

Several theories have been put forward to explain the fact that the coordination compounds of soft acids and soft bases are most stable. Electronic theory says that bonding of the hard acid and base complexes is ionic while the bonding of soft-soft complexes is covalent. J. Chatt's (England) pi-bonding theory can be applied to explain the bonding between the softsoft complexes. According to this heory, the soft acids have loosely seld outer d-orbitals electrons which an form pi-bonds by donating to uitable ligand. Such ligands are hose in which empty d-orbitals are vailable on the basic atom, c.g., P, s, S, I, etc. K.S. Pitzer's (U.S.A.) beory of London and Van der Waal orces explains that the forces between he interacting soft-soft groups epend upon the product of polariabilities of the interacting groups.

Both soft acids and soft bases have large values of polarizabilities.

The HSAB principle finds applicability in various domains of chemical reactions. The simplest reaction that can be explained on this new concept is

Li I + Cs F = Li F + Cs I

This is an exothermic reaction with

33.0 K.cal/mole heat of reaction.

Here the soft iodide ion prefers to
combine with the soft caesium ion.

The hard fluoride ion combines with
hard lithium ion. Many other simple
as well as complex reactions may be
studied on the basis of HSAB concept.

In transition metal complexes, C.
K. Jorgensen (U.S.A.) reported the
grouping of soft bases and that of
hard bases together on a given acid.
The combinations such as CO
(CN), I--- and CO(NH₂)F*+ are

common. In the first case soft CN and I-ligands group together and the latter complex both NH₂ are F are hard ligands.

For heterogeneous catalysis, His AB principle says that soft meta adsorb soft bases. For solubility the rule is that hard solutes dissolve in hard solvents and soft solutes dissolve in soft solvents. Many organ reactions may also be considered in terms of HSAB concept. For example:

CH₂OH + HB = CH₂B + H₂ where B⁻ is a base. Simple alk carbonium ion is much softer ac than the proton.

R.S. L.A.
Lecturer, Chemistry Dept
St. Andrews Colleg
Gorakhpi

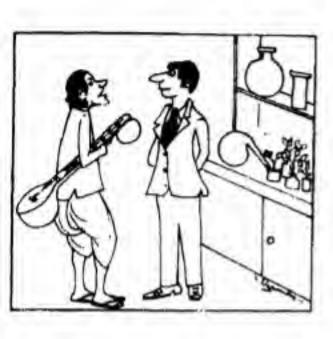
Perception in plants—fact or fallacy

I is hard to visualize the limits of man's thinking capacity so much so that his intuition today tells of emotions in plants too. Yes, plants feel and perceive!

Plants are among the oldest inhabitants of this planet. They alone carry all the share of man's indebtedness, if he thinks that he is at the summit of the civilized. He has been learning how best to utilize the plant kingdom for his benefits. In every moment of happiness and joy. he does not forget the use of plant parts. A husband is never tired of presenting a flower bouquet to his wife till her last breath. Even on death bed, the corpse is scented with wreaths of fragrant flowers. Truly, as Peter Tomkins and Christopher Bird feel, "....there is nothing

lovelier on the earth than a flower nor more essential than a plant. The true martrix of human life is the green sward covering the mother earth".

At the first instance, plant percey tion appears to be an inefficaciou worthless idea, except in some plan visibly sensitive to touch. Toda the question is a moot one open t arguments, both for and again it. In one of the recent meetings of the American Association for th Advancement of Science, reports th New York Times, Cleve Backster, celebrated and foremost America protagonist of emotions in plant vociferated for sentiments of plant He was rebutted, as the panelists i the meeting were not convinced of th depth and integrity of his observation that plants have emotional reaction



"Do the plants like classical music or film music?"

han not, such persons who always the area sympathetic corner for plants are rebuked, laughed at and looked town upon as making baseless arguments in academic spheres.

There is some reason, if not much, a believing that plants feel, as is roclaimed by quite a few workers oday. It is thaumaturgic to rely pon such ratiocinations and prolamations that plants emote and hat plants perceive. Although how uch a phenomenon is possible is a hallenging issue, there are a few experiments which approve this kind of a statement.

Six decades ago, Sir Jagdish chandra Bose performed some experiments which revealed to the puorum of scientific gallery that here were no absolute boundaries etween the two, the living and the con-living. There is enough reason a scribe to plants a life that is imilar to that of man or animal. This is not a speculation but a reveation based upon certain very relible scientific investigations.

Consequent to hearing Bose's lecture, French Philosopher, Henri Bergson, said "The dumb plants had by Bose's marvellous inventions been rendered the most eloquent witnesses of their hitherto unexpressed life history. Nature has at last been forced to yield her most jealously guarded secrets".

To quote from The Secret Life of Plants (Peter Tompkins & Christopher Bird, 1973,) Le Martin stated, "After this discovery we begin to have misgivings, when we strike a woman with a blossom, which of them suffers more, the woman or the flower?"

An instrument that finds an important use in such 'phytopsychological' studies is the polygraph, popularly known as the lie-detector. Variations in the bodily functions, which arise as a result of man's inborn fear of getting caught when doing a wrong thing such as telling a lie, are detected by a polygraph. One of the factors it measures is the 'galvanic skin response' (gsr). The electrodes of the instrument are connected to the skin of the person who is to be examined for either telling a lie or a truth. A small amount of current is passed through them. The instrument draws a graph of subsequent changes in the gsr which may be due, for instance, to sudden perspiration of the person as one might do when telling a lie.

Cleve Backster, an American, is one of the pioneers in the expert use of polygraph for these purposes. He observed how Philodendron, a cactus, recorded unusual signals when a lady lied about her date of She was asked to speak hirth. out a few years none of which were of her birth. Whenever she spoke out these the polygraph showed unusual signals which were all reflections of the Philodendron. But when she told the true year of her birth the polygraph showed usual

signals. Founded on such observations, Backster strongly canvasse for feelings in plants. Aristid Esser, a psychiatrist at Rockland State Hospital, New York, Thoma Eller, a physicist and Dougla Dean, a chemist also carried ou some experiments in which a Philodendron reacted to its owner's false statements as if a polygraph was attached to the person herself.

Employing the polygraph, Backster recorded how instantaneous the plant perception was in response to his sudden idea of burning a lea of the plant. He was trying to study the water-rise from the root to the leaf. He wished to examine the effect of burning a leaf on water rise in the plant. The moment he thought of burning the leaf, polygraph showed a prolonged swing in the tracing pattern. Thus, plants cannot only feel but read man's mind too! Backster observed that plants get so much used to their owners that they can respond to the owner's anxiety over distances as large as 1100 km!

It is believed that Backster's observations on polygraph are not due to plants' emotions but due to static electricity around the experimenter. If that is so, the 'phytophilic' and 'phytophobic' persons must have qualitatively different static electricities. But then, how can the static electricity of a person be responsible for the plumpy and chubby tomatoes which grew from an average-sized tomatoes experiencing a soothing music through headphones? A lot more needs clarification.

"Talk" with plants

"If I talk to my plants I don't know why, but it seems to make a difference when you let them know you like them." It is hard to believe such real conversations. Some persons have been overheard of pologizing to plants after they ad read of perceptions in plants. arlier the same persons always were moyed at the undesired growth of the plants.

At the Biological Cybernetics Labratory of Leningrad Astrophysics esearch Institute, an instrument thich helps "talk" with plants has een devised. The instrument, an utomatic self-recording potentioneter, switches on automatic watering installation after it is "informd" of a plant being thirsty.

Similar experiments conducted beans, sunflower, cucumber, etc., now that vital activities of the lant are subordinate to daily rhyims. During day the plants feel thirst" and so "drink" water every 5-20 minutes. At night, the selfatering operations take nce in 1.5 hours, sometimes even p to once in five hours. rinciple of watering can also be dapted to regulate the environnental conditions of light, temperaare, etc., at the discretion of the lants. This holds a tremendous otential for automation of agriculiral production.

A Russian psychologist, V.M. ushkin and his team of workers elieve that flowers may 'feel' fear, by, pain and such other human motions. In their experiments uman emotions were switched on r off hypnotically. An encephaloraph was attached to the hand of person and to the leaf of a plant little away. Hypnotized person as told of happy or unhappy things hich would arouse in him joy or orrow respectively. The instrument ecorded similar emotions in the lant.

Rev. Franklin Loefir reported the xperiments of Religious Research Foundation (Massachussetts) on seeds and ivy plants. Prayer and love, it is said, promoted seed germination and plant growth. It is no surprise if Dr A. Lord and his students in Drexel University, U.S.A. vociferate for not "what one has to say to the plant but for how to say it."

In India

In our country too, some work has been done in this direction. It is disheartening to note that a similar work done in India did not receive as much importance as did the information coming from a foreign country. It is very pertinent to repeat the name of Sir J.C. Bose who was convinced of plants possessing a heart but could not make others believe it. So he was ridiculed. Later, when Sir Michael Foster, Secretary of the Royal Society, visited his laboratory in Calcutta he was struck with wonder and invited him to share his observations with the members of Royal Society. Bose's views met with unanimous approval and unquestioned acceptance from the audience of the Royal Society. He found that carrots, turnips and horse-chestnut leavessuffered 'blows' much the same way as the metals and the muscles. He could anaesthetize a pine tree using chloroform, uproot, and successfully transplant it.

Indians are reported to be the first to produce significant effects on plants with music. In 1962, Dr T.C. Singh of Annamalai University in Tamil Nadu reported plants responding to music. Excited at such results, G.E. Smith in Illinois conducted an experiment to show that soybeans and maize when treated with music grew better than those without music. Tansen, it is said, could miraculously sing to induce flowering. There is an old saying

that the plants pour forth the sweet smell into the air when joyou girls chat and laugh, sitting, standin or playing around them.

There can be no dispute about plants constituting a large part of the nature. Many poets and writer lived their lives penetrating into nature, understanding it and sharing their knowledge with many other. If there are some beautiful garder with pleasing hue and penetrating fragrance of plants, they are due to incessant attention paid to them, and certainly not out of negligence. It is also due to their adorable responsition of man's scientific and bioaesthetic plan. But, is that all?

If plants really feel and emote, de they also feel that they live for other and not for themselves alone? Aren't they, the crop plants in particular aware that immediately after the grains and fruits are full, they would be uprooted, often mercilessly?

The ancient scriptures speak a lo about the nobility of the plant which always live for others. good, round, red apple will not remai on the tree for long, nor even a attractive sweet rose. Do the plant know it? Do the plants expec something in return from animals How does a plant behave on a poly graph when a delicious ripe mange is gratefully plucked or when a dig nitary affectionately detaches button rose to adorn his coat colla or when a beau goes round a garder plucking various flowers to construc a large bouquet to offer to his belle?

Is man's contentment with plants the happy state of the plants too? How would the female parent respond to an alien pollen on its flower? These are certain questions that require a very deep insight, and man must have broad mind to accept such facts with implicit faith.

Vhat next?

Such a work is being done only at few places. The truth of plant erception does not seem to have ained the gusto for purposes of imploying such knowledge in solving ur problems concerned with plants, ach as lush growth of the plant and proportionately large yield. If the lants can respond to good music is to be seen whether a loud speaker iving some good music increases the yield in an area! At present is impossible to say which music

does the best-western or Indian, classical or light.

A passive perceiver's response to retrospective events could be a very safe assertion that plants too possess a nature basic to man and other animals. The whole theory may have a bright prospect in regard to maintaining a ratio between the number of the hungry mouths increasing unproportionately, and the amount of food available.

D. CHIDVILASA SASTRI
Department of Botany
University of Delhi
Delhi-110007

peptide linkage. The amino grou (-NH₂) and the carboxylic (-COOIgroup of the amino acids are involve in the peptide bond while the remain ing side chains of the amino aci residues are involved in maintaining the three-dimensional structure of the protein molecule. The major class of immunoglobulin found i human blood is ig G. It consists of two heavy (H) chains and two ligh (L) chains. The heavy chain is twice as long as the light chain with abou 445 amino acid residues and a mole cular weight of 55,000. The ligh chain has about 215 amino acid with a molecular weight of 22,000 The light chain is attached to th heavy chain by a disulphide bridg (-S-S-) by half-cystinyl residue at its carboxyl terminal end. Ar other disulphide bridge links bot the heavy chains of an Ig G molecul almost near the centre of the chai and this is called the "hinge" region which gives some sort of flexibilit to the molecule. There are tw intra-chain disulphide bonds in eac light chain and four in each heav chain. Each disulphide loop con tains about 60 amino acids. A tryp tophan and/or phenylalanine residu is invariably seen close to the intra chain disulphide bond.

Much of the polypeptide chain can be followed from one end to the other in the electron density may obtained by X-ray crystallograph of the protein without using an

Of immunoglobulins

A NTIBODY molecules show a remarkably high degree of pecificity in their reaction with the articular kind of antigen molecule hat elicited their production. Since ne number of antigens is enormous, ne number of distinguishably diffeent antibody molecules that an nimal can produce must also be orrespondingly large. A reasonable uess is that at least 106 kinds of ntibodies can be generated in an nimal, but the upper limit is not nown. It is this unique feature of mitless "isotypes" of immunogloulins that differentiates them from Il other known proteins which do ot exhibit such variation within a pecies. Therefore it will be interestng to know their structure.

Serum antibodies are glycoproteins, enerically denominated as immunolobulins. Although much progress as been made in analysing experimentally induced antibodie, the tracture of immunoglobulies has been most intensively studie using suman and mouse myeloms. I roteins

which provide homogenous material in quantities required for structural analysis. It is now widely accepted that serum antibodies and myeloma proteins are closely related molecules. The readers may refer to Immunoglabulins by Prof. S. Ramakrishnan (S.R., Oct., 1972) to know the nature, origin and the defensive role of antibodies during infection. The present article gives a detailed picture of the structure of immunoglobulin molecules.

Proteins consist largely or entirely of chains of amino acids united in

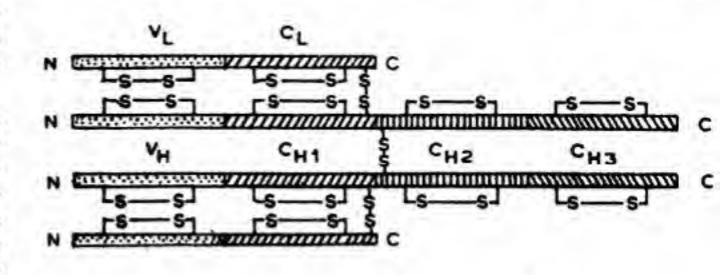


Fig. 1. The structure of Immunoglobulin G

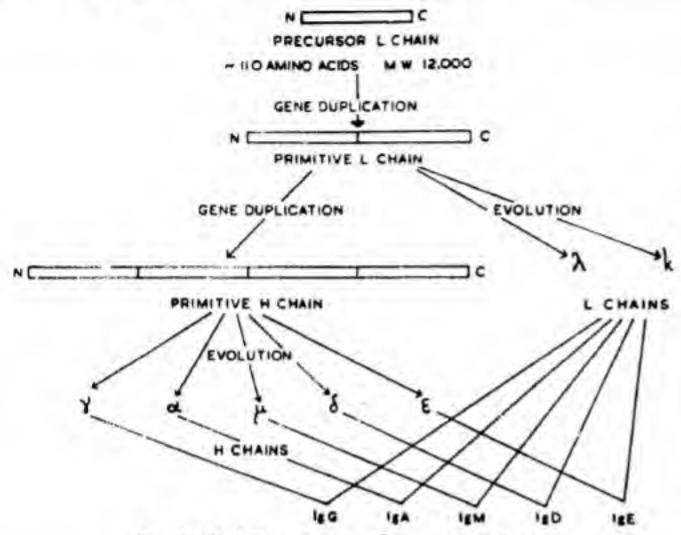


Fig. 2. Evolutionary origin of Immunoglobulins

mino acid sequence. But in some egions of the map it is difficult o distinguish between main chain and losely-packed side chains without equence data. The inner regions of the molecule consist of packed sydrophobic side chains while the sydrophilic groups are exposed outside.

The comparison of the amino acid equences of internal segments of he heavy and light chains has led to he recognition of "homology" reions, about 110 amino acids long. ach containing one disulphide loop. he first 110 amino acids from the mino terminal end of the light and eavy chains constitute the "variable" egion (VL and VH) which combines ith the molecules of the foreign natter. The remaining portion of he chains is called "constant" egion, the light chain having nly one constant region (CL) and he heavy chain having onstant regions (CHI, CHI and CHI) hich resemble each other in heir basic folding and amino acid equence. The constant region is haracteristic for a given sub-class of and H chains. The carbohydrate

moiety is attached to an asparagine or aspartic acid residue in C_{Hs} region (Fig.1).

There are two kinds of residue in the variable regions, those making direct contact with the antigen and those which are involved only in the three-dimensional folding. The latter would be expected to have less stringent requirements than the complementarity-determining This distinction led to the sequences of short stretches of very high variability. Three such "hypervariable" stretches have been indentified so far. It is striking that the differences in the chain length seen in myeloma proteins are mostly confined to these short stretches only. The patterns of insertions and/or deletions of short peptide units are characteristic of the dimensions of the active site and also the chemical environment of the site. The insertion of short stretches would be done by some episomal or other insertion mechanisms under the influence of antigen, if antibody-forming cells are multipotent; or individual sequences might be distributed to immunoglobulin-forming cells during differentiation, if the capacity of individual cells to synthesize ant body is restricted.

The antibody active sites preser in the variable region are considere to have a three-dimensional structur which fits in complementary fashio to the antigenic determinant. Th active site of Ig G consists of a shallo depression of 15×6×6 A° size The structure of a phosphoryl cholin binding myeloma protein has bee thoroughly studied. The two res dues found in close proximity t the phosphoryl choline at the activ site are tyrosine 33 and arginine 5 both of which are apparently hydro gen bonded to the oxygen atom of the phosphate moiety. Lysine (54 is also in close proximity to th phosphate group and would help t neutralize the negative charge i this portion of the phosphoryl che line molecule.

In the different isotypes of immuno globulins studied, about ten glycin residues appear to be invariant i the variable region of each chair The invariant glycines were important in contributing to the flexibility need ed by the variable region to accommo date numerous substitutions at th variable positions. As a result of the absence of side chain, glycin can have many sterically allowabl configurations. This unique pro perty of glycine may permit relative motion of the chains attached to th two ends of the glycine residue. may also allow movement of th site to make most favourable con tact in combining with an antigeni determinant.

Since the L and H chains of immunoglobulin molecules contain homologous regions of 110 amino acids long, it is suggested that the have arisen from a common ancestrate gene which codes for a polypeptid chain of 110 amino acids long. This gene on duplication gave rise to the gene for primitive light chain which on further duplication resulted in

heavy chain primitive gene. These enes for L and H chains uring the course of evolution ave been modified to produce different classes of 10 nmunoglobulins (Fig.2). The diffeent cytochrome proteins, chymotrypnogen and trypsinogen and haemolobin and myoglobin are said to have originated from their respective common ancestor genes like the L and H chains of the immunoglobulins.

M. JAYAPRAGASAM

Biochemistry Deptt., P.G. Instt. of

Med. Education & Res.

Chandigarh-160011

Synthetic food additives as a source of calories

COOD additives may be defined as any substance added to a food give it a desired property. Accordig to the Food and Agricultural rganization (FAO) an additive is a on-nutritive substance added intenonally to food, generally in small uantities, to improve its appearance, avour, texture or storage properties. here are two types of additives, sturally occurring, e.g., salt, acetic cid and vitamin C, and synthetic ibstances such as, antioxidants to revent fat degradation, emulsiers, preservatives as well as subances conferring special physical roperties on foods, e.g., keeping nem moist, prevention of staling, e anticaking.

Synthetic sources of dietary caloes are not only of great interest
s potential food reservoirs for an
expanding world population, but also
fier a new concept of the role of
ynthetic food additives in human
and animal nutrition. Chemically
ynthesized compounds can satisfy
ne body needs of energy and thereore have an important prospect as
ietary supplement in addition to
neir conventional role of food
dditive.

Experimental approach based on inthetic source of energy appears easible, since body fuels do not have specific structure to be oxidized to utilizable energy. The search for synthetic sources of dietary calories was initiated in 1958 at the Massachusetts Institute of Technology, U.S.A., to provide man on long space flights adequate nutrition from natural or synthetic food containing the smallest possible weight and volume.

Of the many known compounds screened, which were not common dietary components but had the potential of supplying metabolic energy, 1,3-butylene glycol (1,3butanediol) was selected as the most promising "high energy" metabolite and was subjected to intensive study. Since then various aspects of the use of 1,3-butanediol (BD) in human and animal nutrition were studied and the findings were discussed in a Symposium of the American Institute of Nutrition at Atlantic City, New Jersey in 1974.

1,3-butanediol in the ester form is widely distributed in nature with palmitic, oleic, linoleic and stearic acid in very small amounts. The compound occurs in corn oil, sheep fat and rat liver. Thus the occurrence of 1,3-butanediol esters in plant and animal life, where they may be expected to have some biological role, makes the introduction of this com-

pound into our "ecology-conscious" society less dangerous. It is well-known that toxic compound do occur in foods and that "natural" does not necessarily mean safe under all conditions. The BD has a very low acute oral toxicity as indicated by a LD of 22-29 g/kg. Relative long term studies on rats and dogs show that 1,3-butanediol is a rather innocuous compound of low chronic toxicity. Multigeneration reproduction studies in rats have revealed no significant adverse The effects. compound also does not cause any mutation.

It has been shown that after ar adaptation period of atleast one week the compound had a calorific value of 6 kilocalories/gram. Feeding a various levels for as long as 30 weeks showed that rats were able to tolerate up to 20% of the diet, without a decrease in food efficiency. Higher levels resulted in an impairment of growth and food utilization. Nutri tional and metabolic studies in humans with BD reveal that isocaloric (equivalent calorie level) substitution of BD for starch in the diet of volun teers caused less negative nitroger balance. Thus, it was shown to b a non-toxic metabolite providing a source of calories for human nutrition.

It became apparent from the world of Dr. Myron A. Mehlman and hi group of the Division of Toxicology Bureau of Foods, Federal Dru Administration, Washington D.C. that administration of BD to rat results in a rapid elevation of keton bodies (acetoacetic acid, β-hydroxy butyric acid and acetone) concen tration in blood, urine and tissues In liver slices BD is metabolize almost quantitatively to acetoacetat and 8-hydroxybutyrate. Oxidatio of primary alcohol such as BD to carboxylic acid is believed to occu via cytoplasmio alcohol dehydroge nase. Dr. Dale R. Romsos and h coworkers of the Department of Food, Science and Human Nutrition, Michigan State University have shown that BD causes an overall decrease in the rate of fatty acid synthesis in rat liver (J. Nutr., 105, 161-170, 1975). It has also been shown that BD decreases the glucose concentration in blood and increases the insulin content of pancreas, thus causing slight amelioration of the diabetic condition.

The idea of using 1,3-butanediol as synthetic source of calories in attle diets is even more recent than he idea of using BD in human diet. n' trials with lactating cows, milk fat percentage and total fat production vere higher for cows fed BD than for ontrols. In trials where growing attle were fed 4% BD, rates of gain and feed efficiency were improved. Thus BD can be utilized effectively as in energy source for cattle and causes o obvious problems with 4% in diets. The major approved direct food se of 1,3-butanediol is as a solvent or flavours, as it is considered to be superior solvent for many essential ils. In addition 1,3-butanediol and atty acid esters can be used as funcional food additives (Abstr. Inst. Food Technol., Annual Meeting, 970) due to its moisture-retaining, acterial preservative and emulsifier roperties. Direct addition , 3-butanediol to foods such as aked products can protect from acteria and mould invasion and reatly extend the shelf-life, although uch use has not yet been approved by ederal Drug Administration (FDA)

Addition of BD to diets in animals esulted in decreased amount of food take as well as decreased deposition

of U.S.A. If the unpleasant taste problem can be overcome and it gets the FDA approval, 1,3-butanediol may have an increased role in food upply as "functional" food additive, reservative and source of calories

of body fat. These observations have some important implications since excessive caloric intake is one of the primary causes of obesity in humans. This condition is also associated with a variety of metabolic diseases such as atherosclerosis and diabetes. Therefore, dietary modification through synthetic food additives may also help to control obesity and related disorders.

Although there is much to learn about the use of 1,3-butanediol, its potentiality clearly calls for a new definition of synthetic food addifrom opening up a new chapter is animal and human nutrition, studies with 1,3-butanediol will serve as model for further investigations of synthetic compounds endowed with dual properties of a food additional as well as a source of calories.

PURABI RANI MITE Indian Institute of Experiments Medicine, Calcutta-70003 SANDIP NARAYAN SINH Department of Biochemistry, Unive sity College of Science, Calcutta-1

Light line in leguminous seeds

IF a section of the seed coat of a legume seed is cut and observed under a microscope, the outermost layer is seen as consisting of columnar cells. They are usually elongated with a pointed end. They have been called by various names like Malpighian cells (Italian name), or palisade cells (because they are of the shape of the cells of the same name in the leaves), or osteosclereid or macro-

sclereid (if they resemble the sclere of the same type). The interesting thing about these cells is not the name but a peculiar streak of light which passes through them slight below the apex at the end of the broader zone of the cells (Fig. 1 (a)). This line has been named 'light line' optic line' or in Latin line lucida.

Corner (1951) during the study

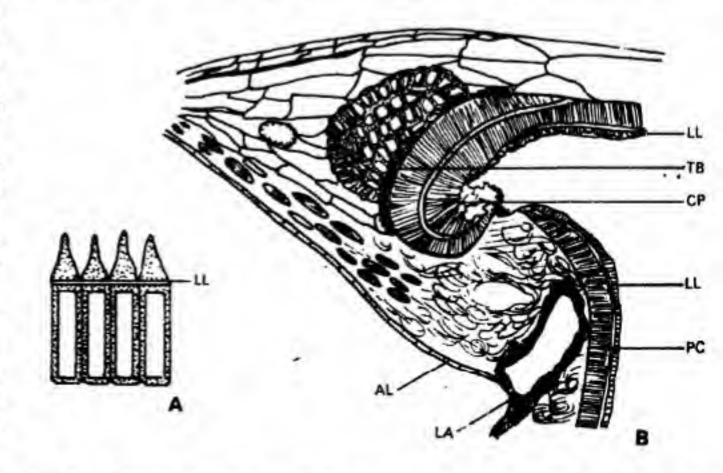


Fig. 1. Trigonella foenum-graecum, transverse section of the seed. A. palisade cells, R. hilum region. AL=sleurone layer, CP -- counter palisade cells, LA=lignified area, LL=light line, PC = palisade cells, TB= tracheid bar.

or man and animals.

the anatomy of the legume seeds has cited many examples where light line may be present throughout the palisade cells of the seed coat or at the localised places like hilum only. Sometimes two to three lines may also be present. In some cases they may be inconspicuous at some places while broader at the other as in the hilum (Fig. 1(b)). This line sometimes gives a false impression that palisade cells consist of two layers. In longitudinal section this line shows a bright spot in the cell wall at the junction of two parts. In surface view it appears as if the cells are undergoing division.

If these palisade cells are treated with ammonical copper oxide, 70% sulphuric acid or 10%-50% chromic scid, the reagents which dissolve cellulose, the apical part of these palisade cells resist the action of hese chemicals, whereas the rest of the body dissolves. This indicates hat apical part of these cells is ion-cellulosic, may be suberised or autinised, while the rest of the part s cellulosic. Under ultra-violet light hese two parts of the palisade cells become more distinguishable. The pical part containing suberin or tutin appears more opaque than the est of the body which appears dark and an empty band could be seen etween these two zones. With noncolarised light, these zones could be esolved into two separate lines, one vithin suberin cap and the other vithin cellulosic region. It indicates hat light line is formed by these wo lines, which are formed due o difference in the chemical nature f the different zones of the palisade ells. This was further confirmed then the refractive index of these yo zones was taken by Hamly 1935). It was seen that refractive adex of spical area was 1.554, while hat of body 1.585. There was a difference of 0.31 in the refractive adices of these two parts.

After this study, it was concluded that light line is not a structural thing but a condition resulting from the juxtaposition of suberin in the caps and cellulose in the lower portion of the palisade cells of the secont.

H.S. Put Botany Dept Panjab University, Chandigar

Magnesium ammonium phosphate a potential multinutrient fertilizer

TN recent years, a group of I inorganic compounds known as metal ammonium phosphates (represented by the general formula MeNH PO. x H,O, where Me is a divalent metal such as Mg. Mn, Fe, Zn, or Cu, and x = 1 or 6) has come into prominence as slowrelease fertilizers. These compounds are capable of supplying N, P and various nutrient cations over long They contain periods of time. both nitrogen and phosphorus in a water-insoluble but plant-available form. Magnesium ammonium phosphate (MGAP) appears to be the most promising compound of this group. It is also a non-burning material and can be applied at high rates without injuring the plants. Other advantages are that the phosphate contained in this compound, unlike fertilizers such as superphosphate and ammonium phosphates which have their phosphate in watersoluble form, is not fixed by the soil, and the nitrogen contained in this material is not subject to leaching losses by rains or irrigation water. G.L.Bridger and coworkers (1962) in U.S.A. recently pointed out the potential use of metal ammonium phosphates as sources of microautricats as well as phosphorus.

Manufacture

MGAP is now commercially manufactured in U.S.A. and the fertilizer grade material contains 8 per cent

N, 49 per cent P,O, and 14 per cen Mg. It is prepared from olivine an rock phosphate by treatment wit H₂SO₄ followed by reaction wit NH. Another process of its manu facture involves the reaction of HaPO4, Mg (OH)a and anhydrou NH. Furthermore, this materia is also obtained as a bye-product it the process of desalination of se water. In India, the desalination of sea water using cheap nuclea power is a practical possibility. I is, therefore, likely that MGA may be available as a cheap fertilize in future.

Agronomic efficiency

Very little work has been carried out in India and elsewhere on the evaluation of MGAP as a source o phosphorus for crops. Z.G. Ilkoys kaya and coworkers in U.S.S.R. reported in 1933 that MGAP was a satisfactory source of phosphorus for peas and mustard but not for buck wheat. A German worker H. Munk (1964), observed in po experiments that MGAP showed very good fertilization effect as compared with other phosphates. H.Y. Ozaki and J.R. Iley (1965) in U.S.A. compared MGAP and other metal ammonium phosphates with superphosphate as sources of phosphorus for eggplant. MGAP produced significantly greater total yield for five harvests of this crop. G.L. Terman and coworkers (1970) is J.S.A. studied in pot experiments he response of rice to several phoshorus sources including MGAP. The performance of the latter was imilar to that of concentrated superhosphate, and nitrophosphates having medium to high water-olubility of contained phosphorus) in the basis of dry matter yields, ptake of total phosphorus and illering.

adiotracer evaluation of MGAP

MGAP and several nitrophosphate naterials (varying widely in the ater-solubility of the contained hosphorus) were evaluated purces of phosphorus for rice, maize, nd wheat in green house experiments onducted by the author at Indian gricultural Research Institute, New belhi in 1969-70. In these experients single superphosphate was sed as a standard source and all ne fertilizer materials were labelled rith radioactive phosphorus (32P), that the fraction of P in the plant erived from fertilizer source could e accurately determined.

For rice crop grown on two alluial soils (pH 6.1 and 8.1) under abmerged conditions, it was found nat MGAP had a higher relative ficiency than superphosphate. lowever, for maize crop grown on ese soils, MGAP showed markedly ower efficiency—especially on the Ikaline soil, when compared with aperphosphate. Similarly, iteritic soil (pH 5.5) and on an lluvial soil (pH 6.7), MGAP had omewhat lower efficiency for wheat nan superphosphate. Summing p, it can be said that MGAP is a romising phosphorus source for ce; however, it appears to be less fective for maize and wheat.

P.C. GHOSH
Il India Co-ordinated Research
Project for Dryland Agriculture,
Prissa University of Agriculture and
Technology, Bhubaneswar-751003

Slag and potassium removal in coal-fired MHD generator

LECTRICAL power may be C obtained from a jet of lonized gas by what is now known as magnetohydrodynamic (MHD) generation process. In principle, this is quite simple and is similar to the conventional generation process. Instead of driving a metallic conductor across a magnetic field, a mass of ionized gas is driven across a magnetic field, whereby it generates electricity in a direction perpendicular to both the magnetic field and the motion. (See Power Generation by MHD, by R.D. Dadhich and M.L. Mathur, S.R. February 1976.)

MHD power generators are commonly classified as direct energy convertors, because they replace the rotating turbogenerator of the dynamic systems with a stationary pipe or duct.

The gas jets which are at present readily available have temperatures in the order of 2200°C and to achieve the necessary electrical conductivity

by thermal ionization (Ionization created by heating a gas is therm ionization. The heat of the ionization tion reaction when expressed in e is called ionization potential.), on a very low effective value of ioniza tion potential (Vi) is required. The it is necessary to add some easil ionizable material to the parent ga (helium, neon or other rare gases for a closed cycle MHD) or to the com bustion products (in an open cycl MHD). This material has bee called seed and alkali metal. Potas sium is the preferred seed materia on economic grounds for the oper cycle MHD system. Alkali meta atoms have loosely bound oute electrons and are readily ionized a temperatures well below 1900°C The velocity of a hot gas stream (V is likely to be around 800m/sec. Th interaction between the conductin fluid (known as plasma) and th magnetic field (B) produces electr city. The electrical conductivity of

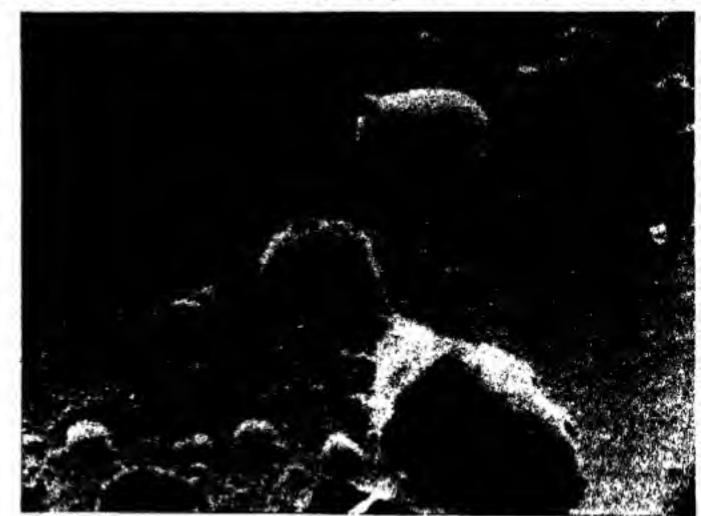
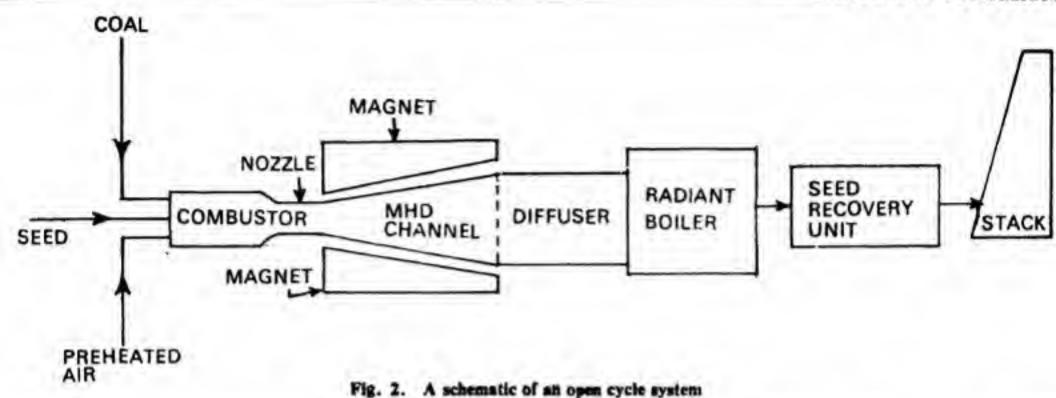


Fig. 1. The cross-section of sing from combustion (University of To



on of temperature and is given by

σα exp (-eVi/kT)

the Boltzmann constant. The ower P per unit volume is given by σ P == ½ σ V²B²

o, if the electrical conductivity is acreased by adding seed with low enization potential, there will be n increase in power output. Of ourse, power P also depends on the quare of the velocity V and the quare of the magnetic field B.

India's coal resources are estimated 83 billion tonnes. They are about 00 times that of the oil and about 00,000 times that of the known eserves of uranium in terms of heat ontent. Coal is an attractive fuel or MHD power plants in India. In the United States coal is the bundant fossil fuel and presently ork is directed towards finding the

neans to utilize coal in MHD power

What is slag?

eneration.

One of the most significant features of coal-fired MHD generators is the presence of coal slag (the ash cortion of the coal that will not burn) in many parts of the system.

The content of slag or ash as well a its composition and properties vary rom one coal to another. Glass echnologists regarded coal slags as

iron-rich alkali-alkaline ear nosilicates. The compositio	
covered by typical coals	is given
below:	
SiO ₁ (Silica)	40-53%
Al ₂ O ₃ (Alumina)	26-33%
Fe ₃ O ₂ (Iron oxide)	3-14%
CaO (Calcia)	2-5%

MgO (Magnesia)	1-2
Na _e O (Sodium oxide)	0-2
K.O (Potassium oxide) 0-4
From this chart it	

From this chart it is obvious that coal slag is a compound of oxide. The composition of slag is various portions of the system depending on the coal available is



Fig. 3. SEM Photo of Crushed Sing Chunks washed with water (University of Tennessee, USA), 20X

different parts of the world, may cover an even broader range than indicated above. A slag rich in K₂O [and perhaps sulfur dioxide (SO₂)] may be expected in some portions of the generator.

The properties of the slag, which vary with composition and emperature, are viscosity, vapour pressures, thermal and electrical conductivities and atomic mobilities. A great deal of research is going on the U.S. Bureau of Mines at Pittsburgh, U.S.A., for finding information on the properties of various coal slags under conditions expected in the MHD generator.

The molten ash from coal produced in the combustion chamber has seen found to produce a layer about 3 mm in thickness) acting like teramic on the electrodes (in the MHD system), protecting them against hot corrosive gases and significantly extending their working lives. Fig. 1 illustrates the cross-section of slag from the combustor.

The combustion process

The gas combination going into he combustion chamber in the case f coal-fired open-cycle MHD system seeded with one per cent potassium arbonate (K,CO,) and heated to etween 2000°C to 2600°C. Pressure sed in the combustion chamber is round three atmospheres. onized gas accelerates in a nozzle nd flows through the MHD channel where it is subjected to a big presure differential between the stack nd the combustion chamber, and which d.c. electricity is directly xtracted at the expense of the theral energy of the gas.

The plasma with its centent of otassium carbonate now begins erforming in the same way as the netallic conductor across the magnetic field.

The combustion products flow

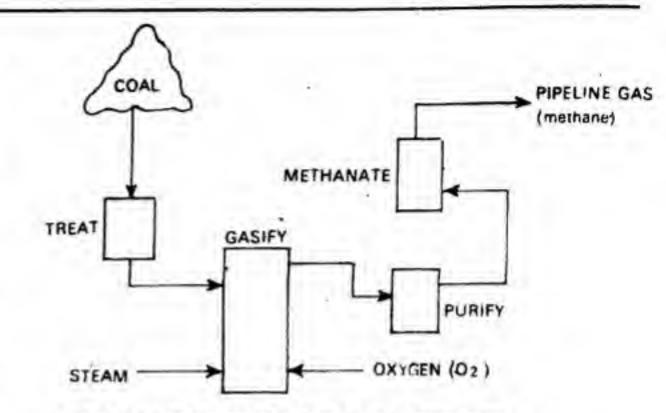


Fig. 4. A flow diagram of basic coal-gasification process

through a diffuser to a waste-heatrecovery boiler where steam is generated by a series of heat exchangers through the seed recovery unit (includes cyclone separator) and finally make exit from the stack. A scheme of an open cycle system is shown in Fig. 2.

Slag and potassium removal

In a large scale open cycle system recovery of seed is essential for the reason that it is expensive and it would cause pollution if released into the atmosphere. Suppose 90 per cent of the seed is recovered and recycled at each stage, then only 10 per cent of the amount required by the generator needs to be suplied and the seed cost is reduced by a factor of ten.

Sulfur compounds in the plasma quickly combine with the potassium carbonate to result in the formation of potassium sulphate. Fig. 3 shows the scanning electron micrograph (SEM photo) of crushed slag chunks (of sizes a few mm to a few cm pieces) taken from the seed recovery unit, washed with water. It clearly shows some traces of potassium sulphate which can be removed by simple water washing.

About 95 to 98 per cent of potassium will be recovered and recycled. Because sulphur dioxide is taken of in the form of potassium sulphate b combining the seed material, the dirty coal containing a few percessulphur can be burnt without a mospheric pollution problems.

 Over 90 per cent of the coal sla which will be recovered as a liquifrom the combustion chamber ca be used to make materials like roa surface aggregrate and buildin blocks.

The potassium sulphate becomes water-soluble ash at about 1200°C Coal slag melts at about 1400°C Potassium is recovered after the coa ash. The sulphate radical is recovered downstream as sulphuric acid or elemental sulphur. In the recycling process a carbonate radical is used instead of sulphate radical.

Many researchers are working of the chemical and physical properties of seed-sulphur-coal slag mixtures over the complete range of temperatures found in MHD power plants.

In any large-scale open-cycle coal fired MHD system, it does not neces sarily mean that coal itself must be burnt in the combustion chamber since there are several processes by which coal can be gasified or liquified. In India gasified coal is used for MHD power generation, since

ere is a large amount of ash preent in the Indian coal (10-15%). ig. 4 shows a flow diagram of the asic coal-gasification process. It is complex chemical transition of solid coal into a form of natural gas. The methanate consisting of CH, hydrogen (H_s) and carbon monoxide (CO), though combustible, is low in calorific content in comparison to

"natural" gas.

LATIKA S.R. BECKER
Univ. of Tennessee Space Instt.
Tullahoma, Tennessee 37388 (USA)

ECTODESMATA (Continued from page 601)

lso occur through ectodesmata.

I has been suggested that even irus particles may use ectodesmata a path for their entry into the ells.

The detection and study of ectoesmata have led to a new outlook with regard to the penetrability in eaves and stems. The characterisic distribution of ectodesmata may e explained on the grounds that ither interfibrillar spaces in these ites are a little broader in diameer because of mechanical factors uch as pressure or tension, hat at these sites excretion of the educing substances occurs within he protoplast perhaps by a process which is the reverse of pinocytosis i.e., ingestion of surrounding fluid y cell). Further studies are requied to answer these questions. Some nore ultrastructural studies ctodesmata and the application of adioactive tracers to the epidermis of living stems and leaves would nable us to determine the interrelationship of the ectodesmata with the cuticle and their role in epidermal absorption and excretion.

Further reading

- Ervin, E.L. and Sikkem J., Ectodesmata of Simlax hispida stems, Phytomorphology, 21, 247-250, 1971.
- Franke, W., Ectodesmata and Foliar absorption, Am. B. Jot., 48: 683-691, 1961.
- Franke, W., Mechanism of foliar penetration of solution, A. Rev. Pl. Physiol. 18, 281-300, 1967.
- Franke, W., Ectodesmata in relation to binding sites for inorganic ions and urea on isolated cuticular membrane surface, Am. J. Bot., 56, 432-435, 1969.
- Schumacher, W. and Halbsguth, W., Uber den Anschluss einiger hoherer Parasiten on die Siebbrohern der wirtspflanzen, Jahrb. Wiss. Bot., 87, 324-355, 1939.
- Schumacher, W. and Lambertz,
 P., Uber die Bezischun

- zwischen der Stoff-aufnahnie durch Blattepidermen und der Zahl der Plasmodesmen in den Aussenwanden, Planta (Berl.), 47, 47-52, 1956.
- Schumacher, W., Uber Ektodesmen and Plasmodesmen, Ber Deutsch. Bot. Ges., 70, 335-342, 1957.
- Scott, F.M., Hamner, K.C., Baker, E. and Bowler, E., Electron microscopic studies of cell wall growth in onion root, Am. J. Bot., 43, 313-324, 1956.
- Scott, F.M., Hamner, K.C., Baker, E., Bowler E., Electron microscopic studies of the epidermis of Allium cepa, Am. J. Bot., 45, 449-461, 1958.
- Seivers, A., Zur Epidermis aussenwand der Fihlborsten von Dionaea muscipula, Planta (Berlin), 83, 49-52, 1968.
- Tangl, E., Uber offene Communication Zwischen den Zellen des Endosperms einiger Samen, Jahrb. Wiss. Bot., 12, 170-190, 1879.



International conference on

chitin/chitosan

THE Massachusetts Science and Technology Foundation and the Sea Grant Program of Massachusetts nstitute of Technology (U.S.A.) plan o co-host the first International Conference on chitin/chitosan in the Greater Boston area either in Novemer this year or in April, 1977. Chitin, a chemical relative of celluose, is found for the most part in he exoskeletal structure of arthrooods (insects, crabs, shrimps, spiders, obsters, etc.). Since its initial invesigation by Ledderhose in 1876, and he identification of a derivative alled chitosan by Gilson in 1895. esearch has continued to find new ses for this resource and practical ecovery methods.

The two-day Conference among ther things will discuss sources, haracteristics, availability, recovery, ost, handling and processing of hitin/chitosan and their market pplications (adhesives, paper, synhetic fiber, films, pharmaceuticals, nimal food, etc). New developments, and future plans and needs will also be considered.

Individuals interested in the Conerence may contact: Mr. Vincent R. oCicero, Manager, International conference on Chitin, Massachusetts cience and Technology Foundation, O, Lakeside Office Park, Wakefield, lassachusetts-01880 (USA).

International symposium on monsoon

THE India Meteorological Department, The India Met. Society and the American Met. Society are jointly organising an International Symposium on "Monsoon" at the Meteorological Office, The Observatory Campus, New Delhi (India),

from March 7 to 12, 1977.

For details write to: Dr. P.S. Pani Director, Northern Hemispher Analysis Centre, Meteorologica Office, The Observatory Camput Lodi Road, New Delhi-11000 (India).

Nobel nutritionist Dam passes away

DROF. Carl Peter Henrik Dam, who discovered vitamin K and got the 1943 Nobel Prize for Physiology and Medicine, died on April 17 in Copenhagen at the age of 81. The observation that chicks develop internal bleeding if they are fed certain diets for several weeks led the Danish biochemist and nutritionist Prof. Dam to the discovery and isolation of vitamin K in the early 1930's and in establishing its role in blood coagulation. In 1944 vitamin K was therapeutically used in human haemorrhage. New-born vitamin K-deficient babies were given vitamin K after birth with the result that thousands of postnatal deaths from haemorrhage were prevented.

Born on February 21, 1895 in Copenhagen, young Dam studied in the Polytechnic Institute of Copenhagen and received his Ph.D. degree from the University of Copenhagen in 1934. He taught and researched for 15 years in various parts of

Europe, under Prof. F. Pregl i Austria (1925), Prof. R. Schoenheime in Germany (early 1930's) and Prof P. Karrer in Switzerland (1935) He came to the U.S.A. in 194 during Nazi occupation of Denmark He worked in Strong Memorial Cli nic Hospital of the University o Rochester and Rockefeller Institute for Medical Research. In 1943 he shared the Nobel Prize with Dr Edward A. Doisy, an American chemist who analyzed the chemica nature of vitamin K and produced it synthetically. He returned to Copenhagen in 1946 to become Professor of Biochemistry and Head of the Biology Department in Polytechnic Institute. Earlier he served on faculty of the University of Copenhagen from 1923 and attained professorial rank in 1929. In 1956 Prof. Dam became Head of the Danish Public Research Institute.

St. Barnabas Hospital New York, 10457

Dubos, Wolman and Elton share ecology award

DENE Dubos and Abel Wolman, professors emeritus of Rockeller University and Johns Hopkins iniversity, respectively, shared the nird annual \$150,000 Tyler Ecology ward with Charles Elton, a retired xford University ecologist and uthor. Dr. Dubos, the 75 year old rench-born microbiologist athologist, has been a leader in sploring the field of human ecology. or. Wolman is a specialist in water urity and engineering. Elton is enowned for his animal ecology udies. The award was announced ecently by Pepperdine University, falibu, California that administers ne award.

Born in France in 1901, young bubos came to the U.S.A. in 1924 nd got his Ph.D. degree from Ruters University (1927). Having served n the faculty of Rutgers University or three years (1924-1927) he ecame Professor of Environmental fedicine in Rockefeller University in 927. Recipient of numerous honoary degrees and prestigious awards, Lasker Award (1948). ich as lational Tuberculosis Association ward (1965) and Arches of Sciences ward (1966), and author of several est-seller books, Dr. Dubos is highly redited for his contributions to antiacquired immunity and otics, berculosis. He discovered a crystalne form of soil bacterial agent which estroys gram-positive bacteria and nus laid basis of new field of chemoierapy.

Born in Baltimore in 1892 Wolnan got his engineering degree from ohns Hopkins University (1915), and served on its faculty (since 1938) and as the Chief Engineer of Maryland Department of Health (1922-39). He contributed towards control of environment for reduction of diseases and welfare of man and development of community water services.

Born in England in 1900, Elton was

educated in Liverpool College and Oxford University. He became Director of Bureau of Animal Population (1932) and Reader of Animal Ecology at Oxford University (1936). He served as an ecologist in numerous zoological expeditions. He authored "Animal Ecology" (1927), "Animal Ecology and Evolution" (1930) "Ecology of Animals" (1933), "Exploring Animal World" (1933) and "Ecology of Invasions of Animal and Plants" (1958).

R.K. DATT

Higher wood production through tree breeding

A T the Forest Research Institute, Dehra Dun two promising hybrid varieties of very fast growing eucalypts have been developed by artificially intercrossing two distinct species of these exotics. Designated as FRI-4 and FRI-5, these new varieties are expected to at least double the per hectare output of future fuelwood or pulpwood plantations in the country. This will also be the first time in the 115 year long history of Indian forestry that pedigreed forest tree material has been developed for plantation purposes.

Eucalyptus, of which there are more than 500 named species and natural varieties, are almost exclusively Australian in origin. However, many of them have been introduced and grown successfully elsewhere as fast growing exotics in several tropical and subtropical parts of the world. The earliest eucalypt introduction in India was that of E globulus, the Blue Gum, in the Nilgiris, more than

a hundred years ago. Lately, anothe species E. grandis has been success fully grown in parts of Kerala fo pulpwood. However, the eucalyp which is currently the most widel planted in the country, in the plain of both South and North India, i mainly E. tereticornis. The new varieties mentioned above have been developed by hybridizing this specie with E. camaldulensis, another close ly related, faster growing and mor adaptable species. In preliminar trials at Dehra Dun, first generation (F1) hybrids of these two crosses have displayed striking degrees of hybrid vigour in both height and diameter growth and have produce at the early age of 4 years, nearly three times more volume of woo than E. tereticornis. F. breeder seed of these two new varieties now awai multilocation testing in the States In the meantime, work on breed ing even better hybrid varietie continues.

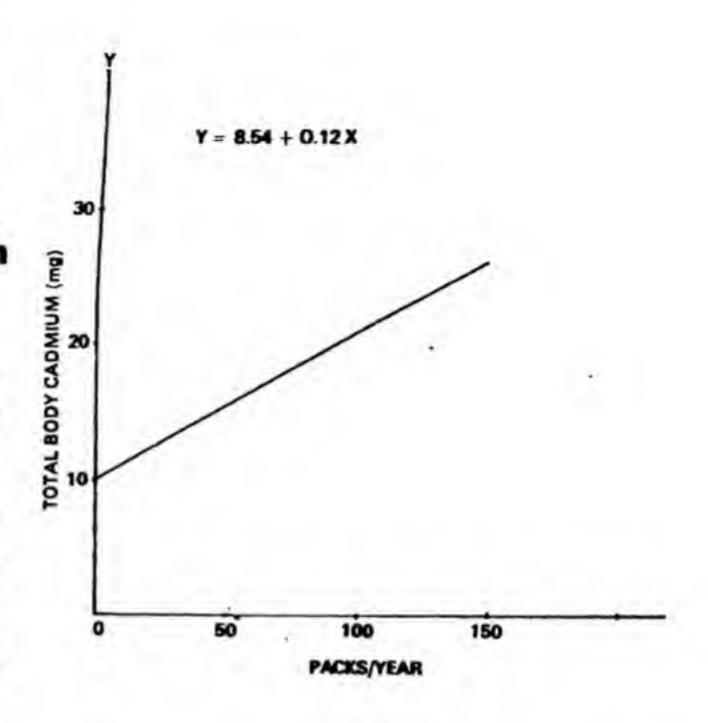


MEDICAL NOTES

Cadmium—a health hazard

CADMIUM is a non-essential ele-ment and highly toxic to man and several other organisms. Acute and chronic poisoning is reported to occur among the industrial workers. Chronic poisoning may occur in occupationally non-exposed persons due to prolonged exposure to a low concentration of cadmium. In acute cases of cadmium poisoning, gastroenteric distress, pain, prostration, pneumonitis and pulmonary oedema may occur. In severe cases liver injury and convulsions have been reported. Chronic poisoning due to cadmium is indicated by renal tubular dysfunction and proteinuria, osteomalacia, anaemia and hepatic damage and hypertension. In the latter, elevated urinary excretion of metals like silver, cadmium, chromium, manganese, lead, tin, titanium and zinc has been reported. It is concluded that it is a consequence rather than a cause of underlying illness.

No survey seems to have been carried out in our country for assessing the degree and extent of the health hazards emanating from exposure to cadmium. Reports from highly industrialized countries are indicative of the fact that cadmium has attained the status of a formidable health hazard in these countries. Japan being a highly industrialized country encounters this hazard all along the western side of island of Honshu. There scores of people have been afflicted with the cadmium dust released from a local smelter plant. The bones of these victims have become brittle and shatter with



.

slightest touch accompanied by shricks of tormenting pain.

Cigarette smoking in both sexes is on the increase. According to recent studies the cadmium level in the smokers is found to be higher than in non-smokers. Estimates reveal that smoking contributes significantly to total body burden of cadmium (Fig. 1). According to WHO technical report, one cigarette contains upto 2 µg of cadmium, of which about 10% is inhaled in the smoke. As ordinary smoker may inhale 2 to 4 µg cadmium per day, while a heavy smoker may inhale 4 to 10 µg cadmium per day.

There are several other sources of cadmium ingestion. Air cadmium levels in areas having no cadmium emitting factories are found to be 0.001 pg/m². At the maximum this level may lead to inhalation of 0.02 pg cadmium per day. Maximum allowable concentration of cadmium

in air is 0.1 mg/m³. Municipal water supply contains less than 1 µg cad mium per litre but higher levels may be found in industrial areas. A normal person drinks about 2.5 litre of water daily. He can ingest a maximum of 2.5 µg cadmium per day through drinking water. Maximum concentration of 10 µg/litre is allowed in international standard for drinking water.

Cadmium always occurs with zine in nature. Commercial zinc which is used in galvanizing food utensile may contain upto 1% cadmium. The glazed potteries containing leachable cadmium may be source a of cadmium ingestion. Dietary intake of cadmium is reported between 50 µg to 150 µg per day depending upon the country. Fortunately, only a small portion (<10%) of the total ingested cadmium is absorbed but absorption from inhaled cadmium may be as high as 40%. Inhaled cadmium is

nore dangerous than ingested. An occupationally non-exposed, non-moker accumulates cadmium mainly rom contamination of food and trinking water. At birth, cadmium is virtually absent from the body but occumulates with age until a maximum level of 20-30 mg is reached at the age of 50 years. One third of otal body cadmium is stored in idney and about 15% in liver, rest is distributed among other organs, iz., adrenals, pancreas, prostate,

estes, lungs and thyroid.

Cadmium activates several enzynes, e.g., acid phosphatase, alkaline hosphatase, histidine ammonialyase nd phosphorylase of rat liver, proliine, carnosinase of swine kidney and holinesterase of rat brain, spleen, eart and kidney. Among the enzynes inhibited by cadmium include denosine triphosphatase, uldolase, holinesterase, glucose-6-p-dehydroenase, glutamine exaloacetic transminase, succinic dehydrogenase of at liver, S-ALA synthetase, catalase, pomide dehydrogenase, tryptophan xygenase, leucine aminopeptidase nd succinic dehydrogenase of rat idney.

Present contribution of urban tmosphere to total cadmium body urden is not significant. uously increasing pollution of the cadmium-laden nvironment by ffluents of factories may lead to larming levels of this extremely oxic metal. Since absorption from nhaled cadmium is much higher han that from ingested cadmium, very effort should be made to limit and to reduce present pollution of he environment with cadmium. Cigarette smoking which contributes ignificantly to the cadmium burden of the body should be curtailed.

L.N. AGARWAL Industrial Toxicology Research Centre Mahatma Gandhi Marg Lucknow-226001

Synthetic double-stranded RNA as anti-tumor agent

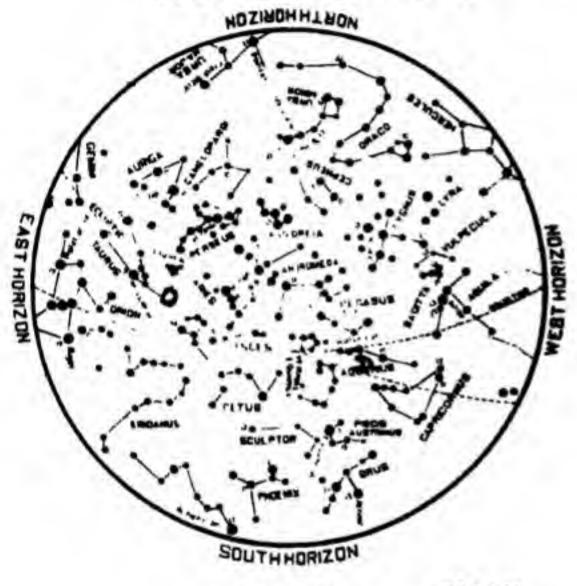
THE synthetic double-stranded RNA, polylnosinic acid poly-Cytidylic acid (polyl. polyC) induces cells to synthesize interferon to develop strong resistance to virus replication and also enhances immunological capacity of the host by an increase in circulating antibodies. But, the most remarkable activity of polyl, polyC is the inhibition of growth of several transplanted tumors and virus-induced tumors (J. Nat. Cancer Inst. 45, 365, 1970). H.V. Gelboin and H.B. Levy also reported that polyl. polyC administered interperitoneally inhibited (i) the formation of skin tumors induced by a topical dose application 9,10-dimethyl benzanthracene followed by weekly application of cortex oil, and (ii) the skin tumors induced by a single large dose application of 9.10-dimethyl benzanthracene (Science, 167, 205, 1970). The inhibition of chemically induced malignant transformation by polyl. polyC has been demonstrated also by Hans Marquardt of Memorial Sloan-Kettering Cancer Centre, New York (Nature New Biol., 246, 228, 1973).

Regarding the mode of action of polyl. polyC it has been suggested that the double-stranded polynucleotide is a strong interferon inducer. Interferon has been demonstrated to inhibit the growth of spontaneous transplanted and virus-induced neoplasms (J. Nat. Cancer Inst., 45, 365, 1970; Proc. Soc. Exp. Biol. Med., 137, 304, 1971). M. Lieberman and his group reported that interferon treatment partially suppressed the X-radiation induced leukemia in mice. R.A. Salerno and coworkers of Microbiological Associates Inc., U.S.A., reported the inhibition of chemical carcinogenesis in mice by interferon (Nature New Biol., 239, 31, 1972). Though polyl, polyl prevents chemically induced malignant transformation in vitro, the mouse interferon preparation fails to prevent the same. So, Hans Marquardt of Memorial Sloan Kettering Cancer Centre, New York suggested that the carcinogenesis inhibitory effect of polyl, polyl is not mediated through the production of interferon (Nature New Biol., 246, 228, 1973).

Microsomal mixed function oxi dases activate many chemical carci nogens during chemical carcinogene sis. P.S. Morahan and his group a the Virginia Commonwealth Univer sity concluded, however, that polyl polyC inhibits the drug metabolish in mice liver by inhibiting mixed function oxidase (Proc. Nat. Acad Sei., U.S.A., 69, 842, 1972). Hence, i has been suggested that the inhibition of chemical carcinogenesis is due to the inhibition of liver mixed function oxidase activity. As a result, chemi cal carcinogens are not converted into the activated metabolites, the chemical carcinogen ultimate (Cancer Res., 30, 559, 1970). Han Marquardt argued that the trans forming ability of some of the carci nogens used does not seem to depend on microsomal enzymes. The syn thetic double-stranded polynucleotid is also effective when added to cell after removal of carcinogens in vitro According to Hans Marquardt, it i conceivable that polyI. polyC, lik other synthetic polyribonucleotide (Proc. Nat. Acad. Sci., U.S.A., 68 2198, 1971), inhibits the activity of reverse transcriptase, an enzym which may have a role in gene dupl (Continued on page 59)

Planets and their positions

NOVEMBER 1976



MAGNITUDES

MOON

10 1.2 3.4.3 O-FULL MOON-7TH

D-FIRST QUARTER-28TH

The

Full moon occurs on 7th at 4-45 .m. and the new moon on 21st at -41 p.m. I.S.T. The moon passes bout a degree south of Jupiter on

8th, six degrees south of Saturn on 14th and about seven degrees north of Venus in the evening of 24th. The lunar crescent becomes first visible after the new moon day in the evening of 22nd.

The moon is at apogee or farthe from the earth on 6th and at perige or nearest to it on 21st.

The planets

Mercury (Budha) is too near th sun to be visible almost during th whole month. It is in superior conjunction on 7th. Towards th end of the month, it reappears as a evening star and sets about half a hour after sunset. It moves from Libra (Tula) to Scorpio (Vrischika) Its visual magnitude is about -0.5

Venus (Sukra), an evening star sets about two and a half hour after sunset during the month. moves from Scorpio (Vrischika) t Sagittarius (Dhanus). Its visus magnitude is about -3.5.

Mars (Mangala) is too near th sun to be visible during the month It is in conjunction with the sun o 25th. It moves from Libra (Tula to Scorpio (Vrischika).

Jupiter (Brihaspati) rises at abou sunset and sets at about sunris during the month. It is in opport sition to the sun on 18th. It is i Taurus (Vrisha). Its visual magni tude is -2.4.

Saturn (Sani), visible in the morn ing sky, rises about half an hou after local midnight during the firm half of the month and about one an a half hours after it during the secon half. It becomes retrograde on 28th It is in Cancer (Karkata). Its visus magnitude is about +0.5.

(Source: Nautical Almanac Unit of the Meteorological Office, Alipon Calcutta-700027)



Venomous fishes

T LEAST a thousand species of fishes are known to be venonous. These species are widely distriouted throughout the world. The enomous organs are either the finpines or spines arming the gill-covers or venomous apparatus on the audal peduncle. All of these organs constitute the stings used for puncuring the predator's body, makinga wound and injecting the venom. The stings contain the venom or poison glands derived from the epihelium of skin, ostensibly as adaptations of mucous glands. The glands secrete a venom which, when injected into man or any other animal, causes severe pain and sometimes, though very rarely, proves fatal. The study of venomous glands forms the subject matter of ichthyotox ism (ichthys-fish, toxicum- poison).

Venomous fishes are represented both in chondrichthyes (cartilagenous fishes) and osteichthyes (bony fishes).

Cartilagenous fishes

Horned or spiny-sharks. Sharks are almost entirely marine creatures. There are several species of horned sharks (Heterodontus francisci) or spiny dog-fish (Squalus acanthias) which are found throughout temperate and tropical seas, inhabiting mostly

sandy bays. They are provided with venom apparatus as dorsal stings: each sting is represented by the anterior spine of each of the two dorsal fins. The venom gland is situated in a groove along the back of the spine.

species of the sting-rays that are found in shallow sheltered bays, river mouths or in sandy areas, inhabiting tropical and warm temperate seas. Some are found in fresh water also. Rays are characterised by the possession of venom apparatus constituting the integral part of the caudal peduncle.

Ratfishes. The ratfishes or Chimaeras are mostly deep-sea fishes found in temperate or cold oceans. The most common species off the European coasts is Chimaera monstrosa. Their venom apparatus comprises a single dorsal sting along the anterior margin of the first dorsal fin. The venom gland lies in a shallow depression at the back of the dorsal spine.

Bony fishes

Catfishes. The catfishes, mostly fresh water, are known by the presence of barbels around their mouth. They usually have scaleless skin and vary greatly in size and

shape. The venom apparatus usually consists of sharp stout stings which are the spines of dorsal and pectoral fins. The fin-spines have venomed glands along their sides within the surrounding skin sheath. The common venomous catfishes are seatstishes (Galeichthys felix, Plotosus anguillaris), bullheads (Ictalurus nebulosus) and Indo-Pacific catfishes (Heteropneustes fossilis).

Weeverfishes. They are smallsized marine fishes found mostly in Eastern Atlantic. Some of the fishes are provided with venom glands located at the tip of the grooves of dorsal fin spines and opercular spines. The common venomous fishes belong to the genus Trachinus.

Toadfishes. They small, are bottom dwelling marine fishes which inhabit the warmer waters along the coasts of America, Europe, Africa and India. They have broad, depressed heads and large mouths. The stings are usually two dorsal fin spines and two opercular spines For example, the tropical America toadfish Thalassophryne has pointed hollow spines on the gill covers and a poison gland at the base of each spine. Batrachus didactylus found off the European coasts, has also stinging spines.

Surgeonfishes. They are deepbodied, often colourful fishes of the reefs. Each fish has a pair of knife sharp curved spines on either side of the body in front of the caudal find The venom glands are located within the spine sheaths. It is an interesting future with the fish that the spine, under normal conditions, if directed forward, but when the fish becomes excited it is extended a right angles from the body, ready for inflicting a deep wound on the predator.

Chemical nature of venoms

The nature of venom found in different types of fishes varies considerably. Since the venom gland for the most part, are not proper

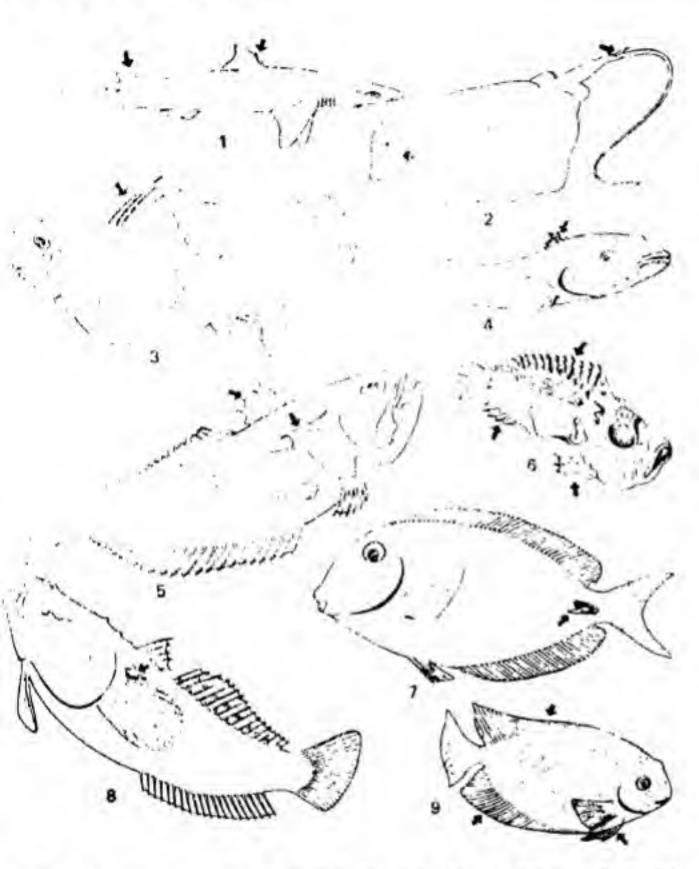


Fig. 1. Some common venomous fishes, 1. Spiny dogfish, 2. Stingray 3. Ratfish, 4. Toudfish, 5. Weeverfish, 6. Stonefish, 7. Surgeonfish, 8. Stargaler, 9. Rabbitfish

solable from the spines, it has not been possible to know conclusively the chemical nature or composition of fish venom. The only knowledge to far acquired about fish venoms is that they are complex mixtures; some are proteins, while others are peptides, mines, quarternary ammonium comtounds, mucopolysaccharides, lipids and saponins.

linical effects

The harm that fish-stings may cause lepends upon the species of the fish, spe of venom apparatus, the part of victim's body inflicted and the amount of venom injected. Most fish stings are of the puncture and lacerated wound variety. Weeverfish tail spines make puncture into the body causing intense pain and discomfort. The stinging by stingrays and catfish produces wounds like that caused by tissue lacerations. These wounds often prove fatal. The stinging by certain types of fishes such as catfish, zebrafish, stonefish, stingrays, spiny-dogfish and weeverfish is more severe. It has been reported that stinging is often accompanied

by fainting, palpitation, feve vomiting and, in extreme cases, heafailure.

Treatment

The treatment of fish-stings ain at alleviating pain, to combat the venom's effect and to prevent secondary infections. In case of punctued wounds, bleeding should be encouraged for sometime and the inflie ed part of the body dipped in he water for an hour. The lacerate wounds caused by stingrays and some cathshes are washed with cold water or sterile salt solution.

A new method of treatment calle "ligature cryotherapy" so being use now a-days. Inmediately following the stinging, the vacuum ties a lighter near the wound to prevent the venon from spreading in the body. There after, the affected body-part metadin the wound is immersed in iced water for five to ten numutes. After . while, the ligature is removed and the affected part is allowed to remain it iced water for about two hours. Ar effective anti-venum for st nefish stings has recently been developed a the Commonwealth Serum Laboratories, Department of Health, Park ville, Victoria, Australia.

VEEN PREM

Biological basis of organ transplantation

That the diseased or musin organs of the body can be replaced by biological grafting is a old concept, organ transplantation however, remained a legend untithe middle of the present centur when Dr. Joseph I Murray and he colleagues in Boston successfull transplanted a kidney from a health individual to he in ntical two when

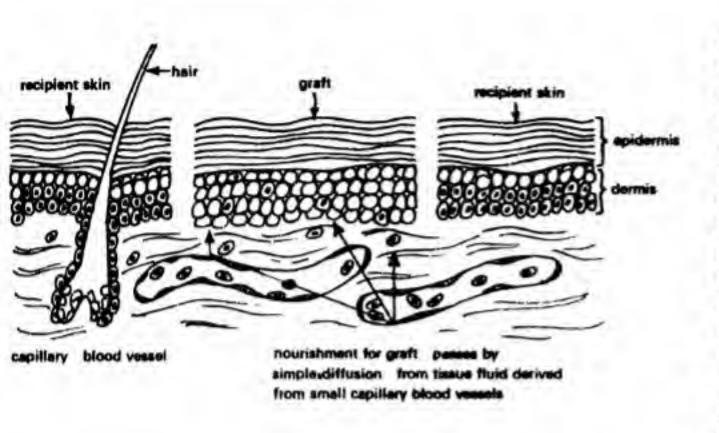


Fig. 1

as dying from an incurable kidney isease.

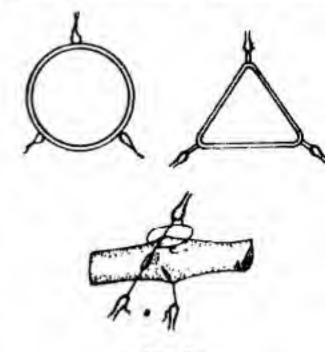
A small piece of living tissue (a in graft of skin, bone or an endorine organ) can be transplanted from ne place to another in the same nimal or from one animal to another ven without making any provision or proper blood supply, because nese small pieces of graft derive neir oxygen and nutritive requireents locally (Fig. 1). After a few days f transplant new blood vessels grow nto the graft and it becomes firmly stablished. However, grafts of hole organs like kidney, liver, heart, tc., do not survive unless their main lood vessels immediately are estored.

It was Alexis Carrel (a Frenchimerican surgeon) who described a
eliable yet simple method of joining
blood vessels using sutures (Fig. 2).
For achieving good results in organ
ransplantation the healthy organ
hould be removed and implanted as
arly as possible because an organ
leprived of its blood supply deterioates rapidly. Each organ however
liffers in its susceptibility towards
lamage due to stoppage of blood

supply (ischaemia). It is therefore obvious that the time lag between the onset of ischaemia and the restoration of blood supply to the graft should be as short as possible. In case of kidney donor, elaborate preservation techniques are not required. Instead, operations on the donor and the recipient are synchronised so that the latter is ready to receive the graft before the transplant is removed from the former. Since restoration of blood supply to the graft takes only 15-30 minutes, the kidney can be transplanted without cooling, but chilling of the organ is always preferred because it retards the ischaemic damage. From cadavers kidneys are removed as soon as possible after death preferably within an hour. The kidneys are then infused with cold solutions and kept cold at 4°C. Meanwhile the recipient can be prepared for operation tissue-typing of the donor and performed if this has not been done before. Kidneys prepared in this manner can be kept upto 8-12 hours with negligible deterioration and moved to long distances in a simple thermos flask.

The tendency of the body to destroy a life-saving graft is the biggest hurdle in the way of organ transplantation. This is because of the fact that the mammalian evolution has preferred in all its species a powerful and complicated defence mechanism against foreign invaders. Unfortunately, however, this self-protecting defence mechanism is unable to differentiate dangerous infective microorganism from the life-saving graft and consequently rejects it.

In early 1940, Sir Peter Medawa and his colleagues studied the behaviour of rabbits towards skir allografts (from the same species at the University of Birmingham England. For the first 4-5 days after grafting allografts and autografts (from the same body) appeared identical, then over the next 3-4 days the allografts turned purple and gradually died while autografts persisted in a state. Experiments or healthy mouse breeding have shown that the factors determining rejection of acceptance of tissue grafts are inherit ed, and segregate in a similar manno like that of blood groups. Breeding of mice by brother/sister mating over fifteen or more generations can result in a line of inbred mice, it which the individuals have identica tissue groups, called the histocompa tibility factors. Grafts between such



Fly. 2

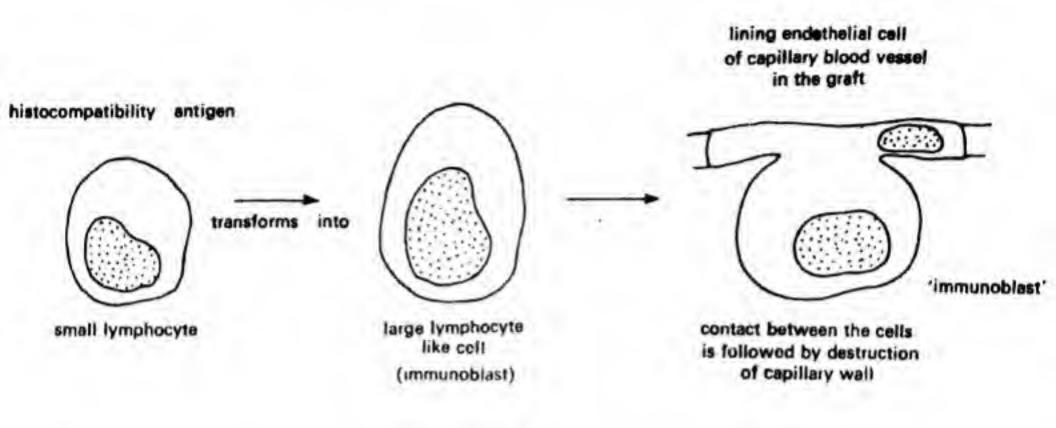
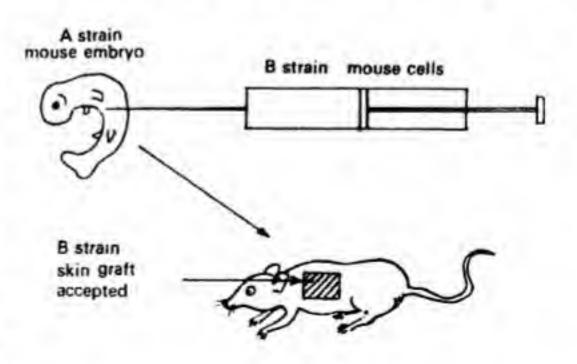


Fig. 3

nice are accepted indefinitely as autografts. hough they were Dr. D.A.L. Davies carefully examined he different parts of body cells and ound that histocompatibility factors re present in the membrane that ncloses the cell. If a mouse is injectd with cell membranes from another nouse, it will react against the nembrane by becoming immune, o that, a skin graft from the memrane donor is destroyed more apidly than would otherwise have een expected. Cell membrane hisocompatibility factors are, therefore, ransplantation antigens. The reognition of a foreign graft and its estruction is brought about by mphocytes. Forty-eight hours after allograft, small lymphocytes hroughout the body transform into arge cells, called immunoblasts, which ifiltrate the graft and probably lead o its destruction (Fig. 3). Other mphoid cells probably change into lasma cells, which produce protein ntibodies that damage the graft orther and may remain in the blood destroy almost instantaneously second graft from the same donor. Since thymus gland is associated

ith the development of lymphoid

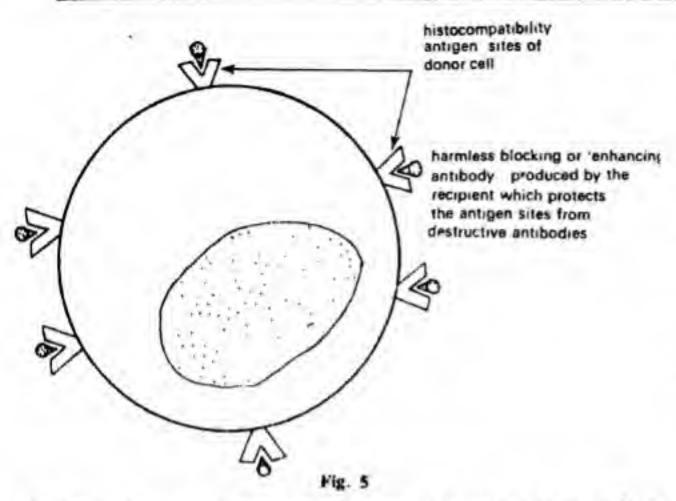
system during neonatal life, its removal from newborn mice permanently impairs development of the lymphoid follicles. Dr. J.F.A.P. Miller of Switzerland found that mice whose thymuses had been removed at birth were unable to reject skin allografts but became extremely sensitive to infections to which they usually succumbed at an early age. During development the lymp hold system is, however, instructed



If adult immunologically competent lymphoid cells are injected into the embryo, it may become a 'runt' due to an immune reaction of the grafted lymphoid cells against the host



Fig. 4



disregard the individual's own ssues as antigens and accept them self-constituents.

Sir Peter Medawar showed that in grafts between non-identical attle twins were accepted indefinily as though the animals had been lentical twins. This phenomenon is cplained on the basis of the fact nat there was mixing of blood in tero between non-identical cattle vins, which resulted in coexistence f red cells of different blood groups the individual calves during adult fe. It was therefore suggested that ne exchange of blood between the mbryo calves presented the developig lymphoid systems with both red nd white cell antigens of the other win. Since the white blood cells ontain histocompatibility antigens, ne calves could treat their respective win's antigens as their own and ccepted skin grafts from their twin later life. This reasoning can be roved by virtue of the fact that if n injection of tissue extract from mouse A is injected into embryos of mouse B, all the offsprings of mouse B will tolerate skin grafts from mouse A, but the grafts from third party will be rejected (Fig. 4).

Recently, transplantation research has made great strides, and it is now technically feasible to graft any desired organ, viz., skin, kidney, liver, lungs, cornea, heart, limb, etc. Prof. Christian N. Bernard of Cape Town, South Africa, set a record in medical history by carrying out the first cardiac transplantation in human beings. It turned out to be shortlived, because of the phenomenon of tissue rejection. However, with judicious use of currently popular immunosuppressive drugs and regimens, viz., imuran, adrenal cortical steroids, actinomycin, anti-lymphocyte serum (ALS), radiation therapy, etc., it is now possible to put a check on rejection and thereby provide permanent acceptance of the grated organ with little unpleasant side effects. Since immunosuppressive

Table 2. Results of 2,347 kidney transplants

Donor	Survival		Longest surviving
	1 year	2 year	
Identical twin 1%	91%	89%	J2 years
Blood relatives 48%	87%	77%	10 years
Cadaver 51%	42%	40%	5 years

Table 1. Showing capacities (in minutes) of various organs (tissues to sustain ischaemia before irreversible damages occur

The second control of the		
Duration in minute		
3-5		
15-20		
30-40		
50-100		
360		

drugs can only put a check on the process of rejection and are unable to completely counter its effect these drugs have to be administered not only for months but for years together. After a few months the drug dosage may be reduced and stopped without sometimes even the graft being rejected. It seems likely that this is because of certain changes in the graft (e.g., specific deletion of relevant antigenic histocompatibility factors) or in the hos (e.g., production of specific blocking or enhancing antibody). The specific blocking or enhancing antibody produced by the host does not destroy the grafted cells but instead coverup their antigenic sites so that they no longer act as antigens (Fig. 5) This is an encouraging sign in the field of organ transplantation.

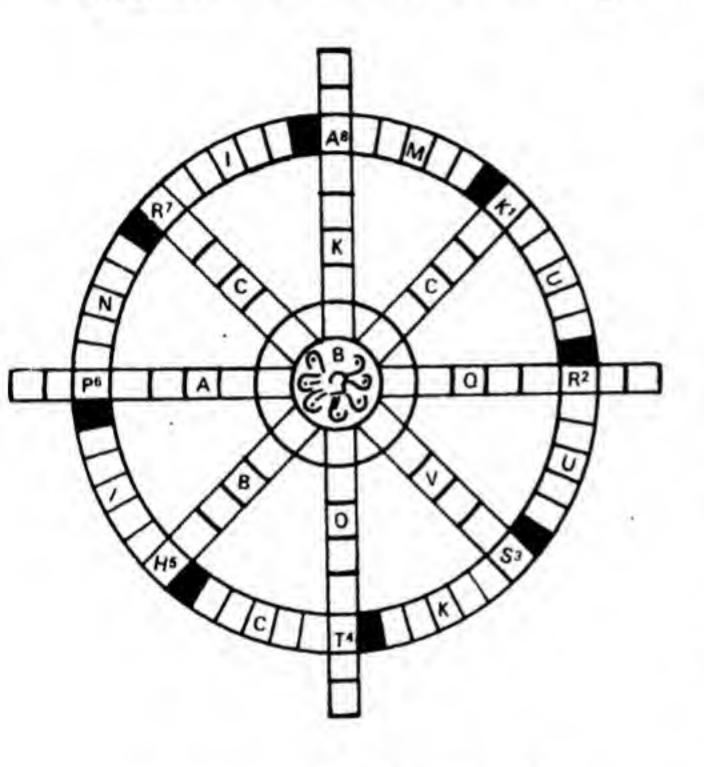
Although the riddle of tissue rejection is yet to be solved and the immunosuppressive drugs hitherto available are far from satisfactory the science of organ transplantation has made great strides (Table 2). These data were compiled by Drugoseph E. Murray of Boston and indicate present status of kidney transplantation. The results cited are encouraging and make the future of organ transplantation still brighter

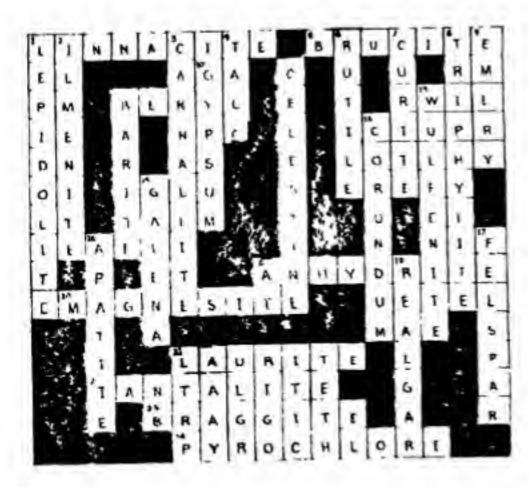
P.C. HURKA Reader, Physiology

Biochemistry, Medical Colleg Ajmo P.N. MATHU

> Principal, Govt. Colleg Ajmo

Science Wheelword Puzzle (Chemistry) CLUES





Solution to crossword puzzle published in September 1976 issue

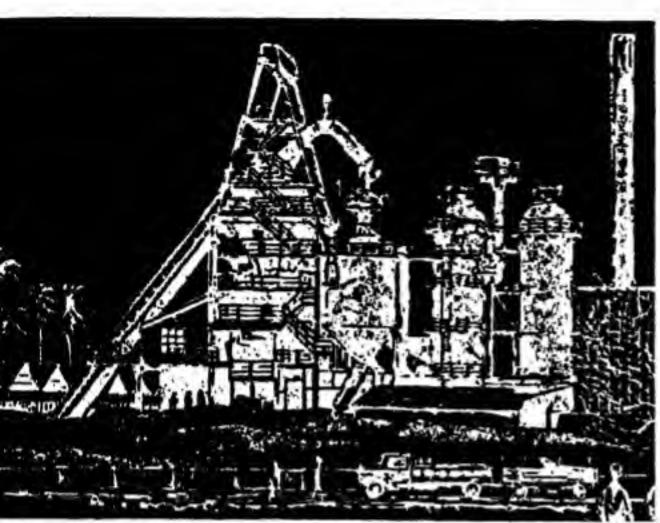
The rim: (Clockwise)

- A name associated with Benzene.
- To submit to a process of reduction.
- These lines are displaced Raman lines towards longer wavelengths.
- A foreign substance mixed with or attached to a given substance to enable the distribution or location of the latter to be determined subsequently.
- A gas belonging to the noble family.
- A constant name in the quantum energy equation.
- This brought death and glory to Madame Curie.
- An isomeric compound generally of a sugar which differs only in the relative position of two atoms or groups.

The spokes: The words begin from the common axle clue no. 9

- An apparatus used in the analysis and testing of milk.
- Formerly the X-rays were named after him.
- A name representing various space lattices.
- An instrument for measuring minute quantities of radiant energy.
- An electrolytic process for the separation of gold and silver.
- When an atom becomes an other atom by ejection of an electron from the disintegrating nucleus, the two atoms are called so.
- A reagent used for the determination of hardness in water.
- A process of polymerization resulting in resins.

PRARHAKAR BELAVADI Deptt. of Chemistry Post Graduate Centre Gulbarga-585105 Karnatuka



SCIENCE IN INCIDUSTRY

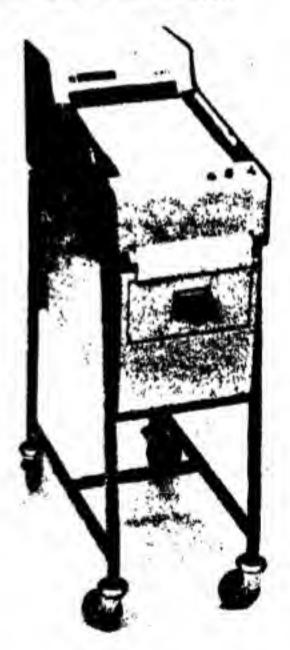
Multichannel analog strip chart recorder

ELECTRONICS Corporation of India Limited (ECIL) has deveoped a Multi Channel Analog Strip than Recorder, CR-270, for incororation in the various biomedical nstruments. This recorder has nulti-speed capability, the and peed can be changed in steps anging from 60 mm/sec to 0.15 nm/sec by a push button switch givng a total speed ratio of four hundred o one. The finger-tip speed control liminates the usual cumbersome nechanical gear changing. This is chieved by "Electronic Gearing" ystem. The recorder is ideally uited for medical instruments ke the Electro-encephalograph re-

cording unit. It also has wide industrial applications and is used wherever permanent records of analog signals are required.

The recorder has fully solid state circuitry, using integrated circuits and silicon devices. No warm-up time is required. The circuitry is protected against fault conditions and overloads, thus improving the performance under adverse field conditions. The writing system is clog-free and requires very little maintenance. The recorder has three functional blocks.

The motor is burn-proof. Even if the motor is stalled intentionally or accidentally for any length of time it does not burn out and remains safe. The ECIL Recorder is absolutely noiseless eliminating the problem of biofeedback in sensitive measurements involving potentials in biomsystem. This makes it an ideal in strument for the recording of biomelectrical phenomena. It can also be used for the monitoring and recording of low frequency signals typical of laboratory and process measurements. The recorder has a channels, each 20 mm wide.



Effective plant growth regulators developed

THE National Chemical Laboratory, Poona has developed a process for the manufacture of chlorocholine chloride (COC) which is one of the most widely used plant growth regulators for increasing the yields of cotton and wheat crops.

(Continued on page 640)



SIMOV'S GUIDE TO SCIENCE:
THE PHYSICAL SCIENCES
THE BIOLOGICAL SCIENCES
THE BI

THE frontiers of science are expanding fast. Never before in the
sistory of civilisation, man's knowedge of nature and universe has
nultiplied as speedily as is seen today.
What is true in science today becomes
loubtful tomorrow, what looks like
permanent knowledge now becomes
emporary the next day.

In this race, the common man appears bewildered with a feeling of being left behind. It is not an imaginary fear, it is a real danger because the common man cannot keep himself apace with scientific advancements of today. The gap between cience and citizen is widening and his is dangerous.

Man must understand science, or else it will slip out of his grasp. He will not then be an enlightened citizen to express responsible opinions on science and its impact on society. He will not be competent to give a direction to science which has become the most powerful force to influence human society politically, economically, socially and militarily.

There are some scientists who undertand that they have a social obligation to carry citizens alongwith them. They communicate science to lay citizens in as simple a medium as science can permit. They bring science out of the laboratories and the pages of research journals and make it a part of the common man's thinking and understanding.

One such scientist who is busy bridging the gap between science and citizens is Dr. Isaac Asimov. A biochemist by education, Dr. Asimov has spent some years writing popular literature on science. The two volumes mentioned above were first published in 1972 and have been republished by the *Pelican* in 1975.

Volume one deals with physical sciences, while volume two tells us about biological sciences. The writer has tried to describe the history of progress of science leading readers to the latest discoveries and observations.

The narrative is simple and exciting. The author has to span a long period of scientific progress, and, so, he has necessarily to take a bird's eye view of the ever expanding realm of science. The bird's eye view has therefore left out details and even some important and recent landmarks of science. This is however negligible, because no writer can in two volumes of popular writing can describe the entire canvas of science which, besides enlarging itself, is becoming more complicated in character.

The two volumes will be a very good addition to the collection of those who are interested to keep abreast with the latest in science.

SECONDARY SCHOOL PHYSICS by N.K. Sehgal, K.L. Chopra and D.L. Sehgal, Sultan Chand & Sons, Delhi, 1975, Pp. viii+108, Rs. 3.50

WITH the introduction of the new 10+2+3 educational system, a large number of books on different subjects are appearing in the market for the secondary school stage. The book in question fall in that line, written for the IX class be three lecturers of the Hans Raj College, Delhi. Syllabus prescribed be the Central Board of Secondary Education has been strictly followed in its

The book is divided into ten units. Each unit contains many illustrative diagrams, some solved numerical problems alongwith the text, and large number of exercises at the end. All physical concepts are explained in detail by giving man examples. A good feature of the book is the inclusion of objective type questions at the end of each unit These questions can help the teacher in assessing the understanding of the pupils.

In the reviewer's opinion, the language of the book is tough for an average IX class student. Probably, shorter sentences with simple words would have been better. Some explanations seem quite involved An average student may find their difficult to follow. The types used if the book and the size of the figures are definitely too small keeping in view the level of the students.

At the beginning of each unit figure is given which is supposed to contain the central theme of that unit Some of these figures do not seem to have much relevance. For example the reviewer fails to understand the connection between the photograp of Lord Krishna and the content of the V unit, namely, "Work an Energy".

On the whole, the book in it present form would be a valuable air for only brilliant students of physics. To bring it to the level of the student for whom it is meant, the book need modifications in the size of type and figures. Simplification of language and of the involved concepts would help in bringing it to the level of a average student.

NARESH KUMA Physics Deptt., Hindu Colleg Delhi-11000 LEMENTS OF COMPUTERS ND COMPUTER PROGRAM-ING by R. Ramaswamy and T.V. rishnamurthy, Published by Mrs. akshmi Ramaswamy C/37, Tirunagar, adurai-625006, Pp. 212, Rs. 9.00

computer is an expensive exury which does the work of one can provided there are two to rogramme and check it. The statement is obviously wrong. The computer is capable not only of colving many types of complex nathematical problems but also olves them quickly.

Many books on computer, its schoology and components and rogramming have recently been ritten. The book under review is so an attempt to present the funamentals of the subject. In the first hapter, a survey of different types of omputers is given. A comparison etween the digital and analogue omputers has been made. A brief istory of computers is also included. To explain the working of a comuter, elementary binary algebra

nd logic circuits have been descried in chapter 2. A few computer
components such as delay circuit,
whibit gate, the eshold gate and
memory device have been briefly
iscussed. A note on decision
making by cornputer has also been
included.

The chapter on organising a comuter problem is interesting. Flow hart has been nicely explained with he help of informative block diarams. This has made the subject asier to understand.

Of the eight chapters, five are evoted to computer language where ortran programming, which is resently the most popular language or scientific work, has been discussed. Once this language is undertood, other languages are easy for

learn. Methods to solve simultaneous linear equations and matrix problems have also been explained.

The authors could have avoided some unnecessary statements (e.g.,... the computers may out-think human mind and gain control over society. Human beings are really dangerous since they can feel love, hatred, greed, a desire for power and many other emotions that can make them act in an antisocial way to join their objectives...) in first few chapters; the treatment would have been better if the chapters were written to the point.

The book is of use to beginners in this field.

VUENDRA SHARMA Microwave Laboratory, Department of Physics & Astrophysics University of Delhi, Delhi-110007

MATRICES AND TENSORS IN PHYSICS by A.W. Joshi, Wiley Eastern Limited, New Delhi, Pp. 251 (1975), Rs. 15

FAMILIARITY with matrix and tensorial techniques is essential to understand the developments in many branches of modern science and technology, particularly, quantum mechanics and relativity. It is, therefore, natural to see a large number of books written on this subject. The book under review is one of the few books written by Indian authors on matrices and tensors.

The book, as the title suggests, is divided into two sections: matrices and tensors. The first section begins with a brief review of the essential concepts involved in linear transformations. Contrary to what the author has claimed, the concept of matrix is introduced as a definition. All the essential ingredients of matrix algebra, which are frequently required

in physical problems, have been given The chapter on Matrices is classical and quantum mechanical gives a nice but brief treatment of rotation matrices, Pauli matrices and Dirac matrices. This section ends with a brief introduction to infinite matrices, usually omitted in most of the books on the subject.

Unlike the manner matrices hav been introduced, tensors are intro duced by analysing a concrete phy sical situation, viz., the effect of applied electric field on an aniso material. The section i treated in a clear and concise manner Sophisticated ideas about matrice have been introduced in a simple manner. They have been given wherever required. The last chapte briefly explains the kind of tensor used in general relativity. It should motivate a graduate student to read general relativity. Very rarely book written on mathematical physics give such a simple presentation o mathematical tools of general relativity.

The author has tried to cover a much as is possible in this small volume. Each chapter ends with a set of unsolved problems. At the end answers have been provided to selected problems. This manner of presenting the solutions of difficult problems, instead of including them along with the problems, is certainly more desirable. Each chapter ends with a list of references where the reader can find detailed treatment of the material dealt in the text.

In many aspects the book could have been further improved. The idea of matrices should have been introduced by analysing some physical situation, especially when the book is meant for physics students. The author could have freely taken examples from physics for making the text easily understandable. In the chapter on diagonalization, the

tample where the elements of natrix are complex numbers. urprisingly, matrices and tensors sed in special relativity have been mitted.

The book, on the whole, is nicely ritten. It is easily accessible to be graduate students of physics. The author needs to be complimented or writing this text which will fulfil be needs of physics students for any years to come. Publisher eeds appreciation for the legible pes, nice format and reasonable rice of the book.

MANMOHAN GUTPA
Department of Physics &
Astrophysics
University of Delhi
Delhi-110007

UNDAMENTAL CHEMISTRY by rof. Donald H. Andrews & Dr. ichard J. Kokes, (Wiley-Eastern eprint), 2nd U.S. Edition, 1969., Viley Eastern Pvt. Ltd., New Delhi, p. 811.

THE last decade has witnessed a sharp increase in the knowledge f chemistry. There is now a visible nange in the methods of presentation the subject. In the past, the curriula in general chemistry at the ndergraduate level were essentially f descriptive nature and were needed be logical and conceptual. Morever, the growing need for an easy nd effective presentation of a vast ubject like chemistry brought about nodernization of the curricula. opics like quantum mechanics, tatistical mechanics, thermodyamics and chemical kinetics were icluded in the introductory courses detail. The student of today is iven a better background of basic rinciples of theoretical chemistry support the subsequent discusions on descriptive chemistry.

With the assistance of Joint Indo-

American text book programme a good number of text books have been made available in cheap Asian editions. The book under review has been published under the same programme. The book satisfies the needs of modern chemistry teaching to a great extent. It has been written to meet the requirements of an introductory course for undergraduate students who intend to spcialize either in chemistry or in related fields. The edition under review has been presented after a few major changes in the first edition. The manner of presentation has been materially altered. The finite difference notation has been replaced by standard calculus notation. New chapters on nature of gases. and thermodynamics have been added. The book presents a balanced treatment of modern chemistry which is rather abstract and complicated for beginners. It has been made more concrete and easy-to-understand by the inclusion of analogies from dayto-day life.

The book has been divided into twenty-seven chapters. Every chapter has been profusely illustrated. The illustrations on atomic and molecular structures with three dimensional effects are excellent and help the reader visualize the processes occurring at the atomic level. The first chapter gives a brief introduction to the architecture of atom. Two further chapters dwell on modern ideas on atomic structure including quantum mechanics and wave mechanics. Chemical bonding and molecular structure have been nicely dealt with. Ideas on resonance and hybridization have been elaborated with important examples. Kinetic theory of gases and Boltzmann distribution law have been discussed after a clear exposition of the ideas of statistical mechanics. Five chapters of the book have been devoted to the discussion of chemistry of elements and their compounds. A vivid introduction of

while discussing chemical bonding Biochemistry and nuclear chemistry have been discussed in the last two chapters. The appendix of the book provides mathematical and physical background to the student, which is essential for the understanding of the text. Exercises at the end of each chapter serve to further clarify the ideas.

Rs. 13.50 compared to \$ 9.95 of the U.S. edition and is negligible in consideration of its valuable contents

R.N. GOE Deptt. of Textile Technolog 1.1.T. New Delhi-11002

DICTIONARY OF CHEMISTRY
by Stanley C. Bevan, S. John Gregg
Anglea Rosseinsky, Applied Science
Publishers Ltd., London, 1976
Pp. 1X-140, £7.00.

THIS concise dictionary contain I ing about 2500 chemical word collected from various works aims a providing their etymological back ground for a good understanding of their meaning. Etymology is th branch of linguistics which is con cerned with the origin, formatio and development of words. Th vocabulary of science is replete with words whose origin lies in Latin an Greek. Since majority of the Englis knowing science readers today hav no background of these languages they lack exact comprehension of several words. In addition to fillin up this gap, the book also familia rises the reader with Greek and Lati roots, prefixes, numerals, alphabet and plurals of various words in it appendices from 1 to 8.

How the words have been described can be seen from the following example:

CHAMPHOR (noun) Frence Camphre, from medival Latin Can hora, from Arabic Kafür, 'Camphor', volatile aromatic crystalline subsance C₁₀H₁₀O, obtained from the amphor tree, Laurus camphora, by listillation.

It is a common knowledge that nost of the encylopedias, dictionaries nd textbooks give a break-up of vords which have been derived from anguages other than English for the penefit of its users. At the same time he authors, as a rule, have selected hose words which are of very comnon use in chemistry. This makes he utility of this dictionary very estrictive particularly only to such eaders who have a preliminary background of science, especially hemistry. Its high cost is another prohibitive factor particularly for students of developing countries. Libraries, however, can afford this complication. The get up, printing and format are undoubtedly of a good standard.

C.B. SHARMA

AN INTRODUCTION TO PTERI-DOPHYTA by A. Rashid. Vikus Publishing House Pvt. Ltd., S. Ansari Road, New Delhi 11000.5, 1976, Pp xi + 383, Rs. 18.

DTERIDOPHYTES constitute a division of plant kingdom Г and include the familiar horsetails. clubmosses and ferns. They were prominent 250 million years ago, but are now an insignificant part of the land flora. Nevertheless, the group commands immense evolutionary importance because it not only encompasses the first land plants, but also represents important stages in the origin of seed habit. The evolutionary botanist is also amazed by its remarkable combination of morphology and growth characteristics of higher plants with a reproduction mechanism which differs from that of bryophytes only in degrees. The form, structure and life cycle of members of this group of plants together with their experimental control

and interpretation are nicely presented in this handy volume. It also meets the long-felt need of B.Sc. and M.Sc. students of botany for a standard text incorporating recent information about pteriodophytes.

After a brief introduction (Chapter I), which also familiarises one with the study of fossils and the classification adopted, the subsequent four chapters deal with the major subgroups, Psilopsida, Lycopsida, Sphenopsida and Pteropsida. Each chapter begins with an account of the salient features of the taxon followed by classification upto ordinal ranks, and then the morphology, anatomy and reproduction of important extant members. The orders, which include fossil forms, especially Psilophytales (Chapter 2), have received less attention than they deserve in the book. Third Chapter gives comprehensive account of Lycopodium. Phylloglovsum, Selaginella and Isnetes and the Fourth of Equisetum. Among Pteropsida (Chapter 5), a fair selection of representatives has been described. Students would have appreciated more information about Pieris, a fern common in Indian gardens and university syllabi. It does not find sufficient space in existing books.

Most refreshing and interesting parts are the comparative accounts of the gametophyte (Chapter 6) and the sporophyte(Chapter 7). In the former, finer details of spore germination, gametophyte development, gametes. fertilization and embryogeny are presented in a manner which reflects the course of evolution and underlines the adaptations in various groups. The controversial and somewhat philosophical considerations on shoot apex organization, stelar system, origin of leaf, evolution of sorus and its hearing on phyllotaxy of terns. morphology of the sporocarp of Marsilea, and heterospory and origin of seed habit are included in the

chapter on sporophyte, which concaptures one's interest and new tion.

Like other plants, presindoplas too have been subjected to much experimentation during recent voits It has led to a better understands: of certain evasive phases of life excle nutritional requirements, develop mental potential and telationelist of various tissues and organ. II. in pect has been grossly negled to the P contemporary books. There is a resizeable part dealing with control and regulation of germination of spores, initiation of gametopt (Chapter 8), sexuality (Chapter 4) regeneration and alternation of gene rations (Chapter 10) and growth and differentiation of the sporophyte (Chapter 11) would be equally assets to students, teachers and tescale he. The last chapter, which is devoted to the origin and evolution of Pierce dophytes, presents a new feature an exposition of the evolutionary processes in the present day member of the group (Chapter 1.)

a subject Pteridology offe considered dull by students breathe a fresh life in this book. The method: cal presentation, simple and unin volved language and several plates of well-drawn line diagrams enable on to comprehend the theme an contents easily. Photographs of som important stages, especially thos which are difficult to 'catch' in th laboratory, would have been a additional help. The reviewer fee no compunctions in recommending the book to all students and teacher of the subject. It is hoped that th publishers would find it possible with government subsidy, to reduc the price further and bring it withi easier reach of students

A.K. BHAINAGA
Department of Botan
Hans Raj College
University of Deli
Delhi-11000

BOOKS RECEIVED

- 1. MATHEMATICS FOR CHE-MISTS by D.M Hirst, Macmillan Press Ltd., Pp. 303, £ 4-95.
- 2 PRINCIPLES OF ENGINEER-ING THERMODYNAMICS by E.M. Goodger, Macmillan Press Ltd., Pp. 190, £ 2.95.
- 3. PROCESS EQUIPMENT DESIGN by M.V. Joshi, Macmillan Company of India Ltd., Pp. 532, Rs. 30.00.
- CHORD ATE EMBRYOLOGY
 by P.S. Verma, V. K. Agarwal,
 B. S. Tyagi, S. Chand & Co.,
 Pp. 383, Rs. 10 (0).

- TEXT BOOK OF PHYSIO-LOGY, VOL. 1 Editors: B.K. Anand and S.K. Manchanda. Tata MaGraw-Hill Publishing Co., Pp. 368, Rs. 42.75.
- FIRST YEAR T.D.C. PHYSICS
 by Kakani, Saxena, Jain,
 Khamesra, Sokhi, The Students
 Book Co., Pp. 616, Rs. 20.75.
- ADVANCED FIRST YEAR T.D.C. PRACTICAL PHYSICS by Kakani, Saxena and Lodha, The Students' Book Co., Pp. 172-XII, Rs. 7.50.
 - ELEMENTARY BIOCHEMIS-TRY by Singh, Garg and Goyal,

- Nem Chand & Co., Pp. 271, Rs. 8.00.
- ELEMENTARY MICROBIO-LOGY by Singh, Garg and Goyal, Nem Chand & Co., Pp. 271, Rs. 8.00.
- 10 MODERN PHYSICS by Bhandari, Sisodia, Jain and Khameshara, Ramesh Book Depot, Pp. 342, Rs.15.00.
- TRONICS by Bhandari, Sisodia, Jain and Khameshara, Rumesh Book Depot, Pp 220, Rs. 8.75.

SCIENCE IN INDUSTRY (Continued from page 635)

When applied to cotton crop, it increases flowering, boll frequency and the yield of cotton. In wheat plants, it prevents lodging and increases the number of tillers and hence the yield. Treated wheat plants give short, stiff straw similar to that of genetic double and triple dwarfs of the Mexican type. To soyabean,

resistance to drought, salt and cold.

India uses nearly 30 tonnes of COC every year, most of which is imported. Field trials of the NCL process have been taken and the product conforms to the standard compound. Raw materials required for the NCL process are available indigenously.

For a plant of 30 tonnes per annum capacity the estimated capital outlay would be Rs. 4.99 lakh (Rs. 3.00 lakhs on land, building and equipment and Rs. 1.99 lakhs as working capital). The cost of production according to the new process comes to Rs. 21.5/kg against the market price of Rs. 60.00/kg.

BOOKS FOR COMPETITIVE EXAMS.

Career Books		General English	
Suniti's Pattern Book for		Varma's Issay for the LA.S.	
Science Talent Search Exam.	20.00	by Shakti Batra	15.00
Suniti's Comprehensive Book for LLT.	Section 1997	General English for Competitive Exams.	12.50
Suniti's Medical Colleges		How to Write I flective Linglish	12705
Admission Guide	20.00	by Shakti Batra Guide to Precis Writing	15.00
	10.00	Art of Better Speaking and Better Writing	6.00
Managerial Aptitude Tests	10.00	How to Study, to Make Notes	4.00
Encyclopaedia of General		Common Errors in Linglish and How to	4.3/4
Knowledge and World Affairs	18.00	Avoid them	5 00
Guide for Admission to Medical		Varma's Book of Idioms and Phrases	5 00
Colleges by Major Jodh Singh	18.00	College Essays by Shakti Batra	7.50
Super Intelligence Tests	6.702.50	Dictionary of Proverbs, Literary Gems,	50000
by Major Jodh Singh	10.00	Idioms and Phrases	6.00
[19] [19] [19] [19] [19] [19] [19] [19]	10.00	Luglish Lucrature	15.00
General Knowledge, Current Allairs,	4.00	Lissays, Precis and General English	6.00
Interviews and Who's Who	4.00	Spot Essays by B.N. Ahuga	12.50
do (Hindi)	6.00	Top Essays	15,00
G.K for Competitive Exams. Successful Interviews	10,00	Practical House Keeping by N.N. Kapur	7.50
Modern Interviews by Shakti Batra	6.00	Humorous Quotations by J.S. Bright	4,00
Guide to Railway Service Commission Exam	9.40.	Best Quotations for All Occasions	5.00
Guide to Banks' Recruitment Tests	6.00	333 Great Indians	5,00
Guide to Probationary Officers' Exam.	15.00	Gandhi's Teachings by Shakti Batra	6,00
Guide to LA.S. Exam. (Solved Papers)	18.00	Letters	
Guide to Indian Forest Service Fxam.	12.50	1000 Letters	6,00
Guide to Clerks' Grade Exam.	9.00	Modern Business Letters	6.00
Guide to Assistants' Grade Exam.	18,00	Modern Letters	5.00
Guide to Commissions in the Armed		Love Letters	5.00
Lorces by Major Jodh Singh	7.50	Hindi Sangari Nibandh by Prof. Dum Lal Varma	12.50
Guide to Combined Defence Services' Exan	1.	Samayık Nibandh by Prof. Ram I al Varma Subodh Hindi Nibandh	5.00
Vol. 1 for Short Service Commission		Patra Lekhan Kala	5.00
by Major Jodh Singh	15,00	Business Management	J.1147
Guide to L.I.C. Officers' Examination	18,00	Practical Business Management	12.50
Guide to Group Discussions	7,50	Office Procedures and Drafting	12.50
Guide for Admission to Army Cadet		How to Negotiate, Bargain and Enter	12,00
College and Army Higher Secondary	** ***	into Collective Agreements	24.50
Exam. by Major Jodh Singh	22.50	Stores Procedures (Materials Manage-	100
Multipurpose Objective Arithmetic	7.50	ment) by N.N. Kapoor	25.00
by Major Jodh Singh	7.50	Varma's Ready Reckoner	5.50
Varma's Guide to Stenographers'	mm	History	
Exam. by O.P. Varma	9.00	Indian History (Hindu Period)	12.50
LQ, Made Easy by J.B.S. Aurora	5.00	Indian History (Medieval Period)	12.50
Popular I.Q.	6.00	Indian History (Modern Period)	12.50
Improve Your I.Q. by J.B.S. Aurora Scientific Knowledge	5.00	British History (Tudor Period)	9.00
Assistants' Grade Arithmetic by Sushil	2.00	British History (Stuart Period)	9.00
Kumar and M.M. Sharma	6.00	British History (Hanover Period)	9.00
Constitution of India with Comments		History of India Maps (All Periods)	9.00
and Criticism	7.50	History of Europe in Maps	9.00
Constitution of India (Hindi)	7.50	History of Britain in Maps	9.00

Packing and Postage is charged extra on small orders.

FREE Postage on every order of Rs. 50/- and above.

Ask your book-seller or send your orders to:

VARMA BROTHERS

21, SHANKER MARKET, P. B. 531, NEW DELHI-110001

THE WONDERFUL WORLD OF COLOUR!



Think what a difference colour makes.

Colour pleases the eye, creates happiness and it sells.

Colour-Chem pigments beautify textiles, paints, printing inks, plastics, rubber, leather, myriad other materials.

Make your world even more beautiful with lovely Colour-Chem pigments.



COLOUR-CHEM LIMITED Ravindra Annexe Dinshaw Vachha Road Bombay 400 020

in technical collaboration with: Bayer AG., and Hoschst AG., West Germany.

SCIENCE REPORTER

HALES, DOLPHINS AND PORPOISES OF THE INDIAN COAST IELD IS A UNIVERSAL PHENOMENON VEEDS—THE ENLARGING MENACE UTTING WATER HYACINTH TO USE WHAT IS EUTROPHICATION?

HE UMBRELLA OVER THE



Re. 1.00

UNCIL OF SCIENTIFIC INDUSTRIAL RESEARCH





From Alchemy to to-day's Science

Alchemy began by an obsessive urge for transforming the baser metals into gold. The experiments of Alchemists recorded under mystic terminology, gradually led to the discovery of metallic arsenic, antimony and phosphorus.

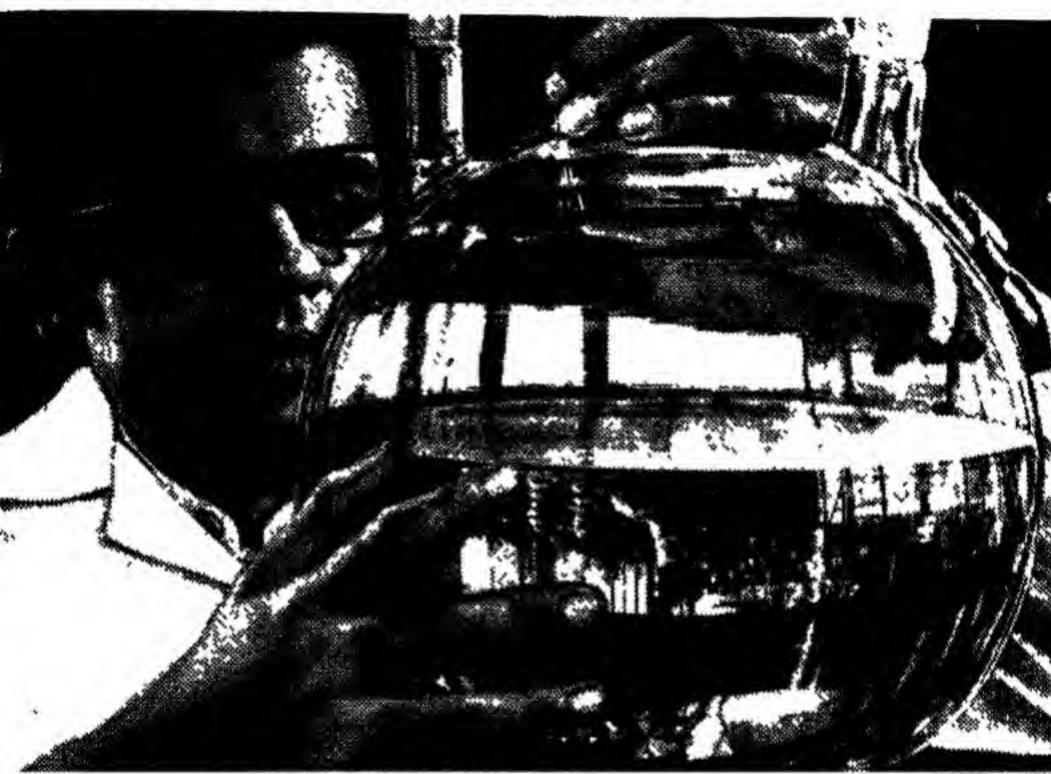
We at Surabhai M. Chemicals have the obsession of alchemists, not for producing 'Philosopher's Stone' but for providing an ever increasing range of ultra high purity and trustworthy laboratory reagents—the tools of modern chemists.



SARABHAI M. CHEMICALS

Where scientific tradition of ingenuity never dies.

"Our great step backward."



When we make a product, we take a step back into the science and technology of the industrial raw material.

Take, for instance, soaps We are not merely soap makers.
We manufacture processed triglycerides from several
non-edible oils with specific technologies developed by us

Or Nickel Catalyst for hydrogenation. We not only manufacture a more efficient catalyst but also use mainly recycled Nickel as raw material!

Or Fine Chemicals used in the Soap and Detergent industry. We make a range of them with technology based on our own R&D

Or process equipment for Soaps, Detergents and Fine Chemicals We make all our plant indigenously—most of it engineered by us.

And we are working on many more to come—industrial raw materials and processes based on Research and Technology.

Our great step backward to take more steps forward.

Hindustan Lever Ltd.

Relevant Technology for the Millions

to our contributors

- SCIENCE REPORTER welcomes articles of absorbing interest on science and technology. Contributions
 published in the Journal will be paid for.
- Articles should be sent to the Editor, SCIENCE REPORTER, CSIR, Rafi Marg, New Delhi-110001.
- The form and manner of presentation of the subject should be easily understandable to the undergraduate level.
- The length of the article, written exclusively for the Journal, may be about 2500 words.
- The matter should be typewritten, double space on one side of the paper; the original and a carbon copy are to be sent.
- The article should preferably be illustrated; captions and legends typed separately and attached at the end of the article. Photographs should be on glossy paper.
- While quoting names of scientists, etc., their initials, nationalities and periods of research under reference should invariably be mentioned. All weights and measures should be given in Metric Units.
- A short note about the contributor should also accompany the article. The note should contain age, academic accomplishments, important assignments held, fields of research and hobbies.
- Articles or illustrations published in the Journal can be reproduced with permission of the Editor.
- The Editor reserves the right to reject even invited articles without assigning any reason.

SUBSCRIPTION	To The Editor SCIENCE REPORTER
	C.S.I.R., New Delhi-110001 Please enter/renew my subscription to SCIENCE REPORTER for one year. I am sending Rs. 10.00 by M.O/P.O. No
	Name Full Address (in capitals)
	PIN (Old Subscription No) Signature NOTE: Please mention old Subscription No. to M.O. coupes also.

SCIENCE REPORTER

VOL. 13 NOVEMBER 1976 NO. 11

644 LETTERS

648 PLANETS AND THEIR POSITIONS - DECEMBER 1976

MAIN ARTICLES

649 What is a field? Rama Kant Pandey

654 Ozone—the earth's protective nubrella N.D. Kaushika

657 Weed menace in India V. Bhaskar

660 A close look at Indian safety razor blades B. K. Guha
S.S. Bhatnagar

664 Mitechandrial DNA—the second genetic material S. Ramakrishnan

667 SCIENCE SPECTRUM

Island of nuclear stability — Proton radiography - Put water hyacinth to use— Eutrophication: cause and control — World amino acid demand — Whales dolphins and porposes of the Indian coasts — Some biologically active organo-silicon compounds — Snake poisoning — Insects conserve water — The AKUFVE technique — Beetles that can bury a mouse — Earwigs

683 NEWS AND NOTES

Dr. P.P. Rastogi -an Interview Prof. Ramalingaswami gets WHO Award

685 MEDICAL NOTES

Poliomyelitis—infantile paralysis—Red dye No. 2 linked to cancer— Leprosy bacterium grown in laboratory—Pica, a major cause of lead poisoning in children

688 SCIENCE FOR THE YOUNG

Leather in many forms—False fishes of the world--Rule of divisibility— Comets and cometphobia-- Science oddities

695 SCIENCE IN INDUSTRY

Geothermal energy, and rural development Technology for rural development and industrial growth

699 BOOK REVIEWS

First Year Physics A Status Study on Population in India Vol III-Objective Evaluation-Gold Plating Technology-Five Eminent Scientist

Annual Subscription

Science Reporter is lamed monthly

for the statements and opinion

advanced by contributors.

The Council of Scientific & Industrial

Inland : Rs. 10.00

Foreign : \$ 5.00

Editor: S.P. Ambesta Asett. Editors: C.B. Sharma, Zaka Imam Editorial Staff: Dilip M. Salvi, -aha Misra Sales & Advt.: G.N. Jaswal, G.F. Valpeka

Production: V.S. Chuturvede



Ultrasonics

Sir, S.R. of March 1976 contains very informative article on ulrasonics. There could be a brief nention about production of ultraonic waves also. While dealing with optical diffraction method of measrements, it is stated that for the tationary wave system the spacing of the phase grating formed by the iltrasonic beam passing through a ransparent medium is $\lambda/2$. It is rue that the modes of the stationary vaves produced in the medium are eparated by $\lambda/2$. But at any insant alternate nodes are condensaions with rare-factions in between. the grating element of the phase rating is has in progressive waves nd not $\chi/2$ as mentioned in the rticle.

> A.O. MATHAI (Retd. Prof.) Kandanad, Kerala

Leap second

Sir, I would like to add the following to the article The leap second S. R. April, 1974).

It was mentioned in the article nat the phenomenon of annual hange of duration of the last minute f a particular day from 60 seconds of 1 or 59 seconds is termed "leap econd". It appears that the name leap second" has been derived on an analogy with "leap year", now feel that the above phenomenon should, in all fairness, be trimed "leap minute" instead of

"leap second" for the following

In a leap year, the idea behind naming it as such has naturally originated from an extended year with an additional day. The fact that one day actually leaps in that year was not taken into consideration in its nomenclature; that phenomenon, universally known as a leap year, was never called a leap day. On an identical reasoning, the addition or deletion of one second with the last minute of a day, as and when done by BIT, should better be referred to as an occurrence of "leap minute" because the duration of a minute is altered thereby.

International bodies like CCIR, CIPM, CCDS, and BIT should reconsider the nomenclature.

Department of Physics

Jadavpur University

Calcutta-700032

Vitamin A

Sir, Thanks for publishing Role of vitamin A—new concepts (S.R. Jan., 76) by Nisha Bajpai.

The author has meticulously dealt with the contribution of retinol to the visual process but has nowhere mentioned that retinol is actually the most stable form of vitamin A₁ and is the most active form in curing "vit. A" deficiency.

Since two more biologically active geometrical isomers of vitamin A₁ (all-trans), neo-vitamin a from rat liver and neo-vitamin b from eye, have been isolated and a second compound vitamin A₂ (3-dehydroxy retinol) has also been isolated, their differentiation becomes necessary. A normal human being requires .0007 gm of vitamin A₁ (retinol) daily.

In this context, however, it would be of interest to note the recent findings on the role of vitamin A in preventing blindness. Dr. G. Venkataswamy, Prof. of Ophthalmology, Maduras Medical College, in his paper at the Afro-Asian Congress of Ophthalmology at Madras said that attempts had been made to prevent blindness by administering vitamin A to pre-school children It was estimated that 100,000 children go blind every year in the world due to keratomalacia. A studiof keratomalacia cases in India before and after the administration of vitamin A, at Erskin Hospital, Madurai; Sarojini Deservice Hospital, Hyderabad; and other hospitals did not show any change as a result of vit. A administration

PANKAI SRIVASTAV

Deptt. of Chemistr

University of Allahaba

Allahaba

Vitamin C

Sir, I have read with interest the article Loss of vitamin C I diseased plants S.R. April, 1976 b Jamaludin.

The author has given numerou examples of losses of vitamin C is plants or their products due to fun gal diseases but has totally omitted even the mention of such a happen ing due to plant virus infection (Z. Pflanzenkrankhtein und Pflan zenschutz 78(5), 355-56, 1971), e.g. the case of tomatoes due to tobacco mosaic virus as well as other exam ples as reviewed therein. Moreover a number of bacteria and plan parasitic nematodes have also been reported to cause deterioration in the quality of different plant products upon infection of the concerned plants.

DR. S.M. PAUL KHURANA

Editor

Indian Potato Association.

Central Potato Research Institute

Simila

Biology syllabor

Sir, Prof. S.C. Maheshwari, the Shanti Swarup Bhatnagar Prize winner for biological sciences for 1972, is right when he says that the present syllabit need overhauling suit the needs of modern biology S.R. March 1976, p 178) The introuction not only of physics and nemistry but also of mathematics and atistics to biologists is important. ur syllabii must be interdisciplinary that scientists of different interests an find the way easy for their con-Maheshwari's ibutions. Prof. eling that "our students are good, ut the training imparted to them defective" is predictive of the necesty for overhauling the syllabii nd introduction of interdiscipliary courses.

A.K. KUMARAGURU

Research Scholar

entre of Advanced Study in Marine

Biology

Annamalai University

Porto Novo 608502

Monopoles

Sir. My thanks to Sri Tapash hakraborty for his article The eluive monopole (S.R. Feb., 1976). The rticle is interesting, for it dealt with a recent discovery in physics. The author has mentioned many ew changes that will be necessary the concept of monopole is acepted. Another basic modification n magnetism will be in the present concept of lines of force. At present, ines of force due to a magnet are considered closed. If monopoles exist, we should be able to create nagnetic field where the lines of force will be open, just like the electric lines of force in an electric field. However, we have to wait till the existence of monopoles is confirmed.

ASHUTOSH MEHER
Deptt. of Physics
Gangadhar Meher College
Sambalpur (Orissa)

Mercury pollution and fish intake

Sir, We are thankful to Daljit Singh and Iqbal Singh of Punjab Agricultural University, Ludhiana for their warning about the methylation of mercury and its deleterious effect on all kinds of fishes (S.R. April, 1976). We shall be thankful if any private or government body in India points out the safe limit of mercury in fishes in and around Calcutta area. Calcutta is a riverine harbour and on both banks of the Hooghly are situated numerous paper, caustic, plastic, paints and pesticide factories. Calcutta alone must be consuming more than a thousand tons of mercury annually by way of fishes. It will be in the public interest for a government or private body to throw light on mercury contamination of fishes in Calcutta. We had written to many authorities including the Government Health Department and Fisheries PALTA but without any response.

> S.H. VIKRAM M. BHAT V. HEMRAJ 92-A Bowbazar Street Calcutta 700012

Blood groups

Sir, I thank Sri Bhattacharya for Blood groups and human diseases (S.R. Feb., 1976). I want to know if there is any psychological disease related to blood groups.

The Rh (Rhesus) blood group is of great clinical importance. Is there any disease related in particular to the blood groups?

G. BALAKRISHNA
Thimmapuram
Anantpur Distt. (A.P.)

Psychological (mental) disease is caused in significant excess in persons of B group blood. The disease is considerably less in A group persons. W.C. Boyd, Department of Biochemistry, School of Medicine, Boston University,

U.S.A. published a monograph Blood Groups in 1939 wherein he mentioned the relation of blood groups to psychological diseases.

Some diseases are related to Ri (Rhesus) factor of the blood group Pulmonary embolism, chronic ul cerative colitis, malignant neoplasm of gastrointestinal tract, duodena ulcer occur in Rh-negative persons. The work of Ch. W. Mayo and J.O. Fergeson, American serologists may be mentioned in this context. They published in 1953 a paper in the Journal of American Medical Association entitled Are certain disseases associated with specific blood groups or Rh antigens?

J. BHATTACHARY

11

Sir, I read the article Blood group and human diseases by J. Bhattachary (S.R. Feb., 1976) with great interest I like to have some more information.

I. In the figure it is shown that the serum of an O group man contains ab agglutinin. Even if the serum contains either a or b or no agglutinin, it will still be compatible as the corpuscles contain no agglutinogen.

Is it possible for a man with C group to have either a or b or no agglutinin in his serum?

- 2. If the donor is of O group and the recipient is of A or B group would the ab agglutinin in the dono blood not cause agglutination of the corpuscles of the recipient blood?
- 3. Can the blood group of a offspring be predicted from th knowledge of the blood groups of the parents?

S.V. Jose Dandia Baza Baroa

1. It is not possible. It will lead to anomalous serological constitution. 2. Here the donor is universal of group). He has access to any lood group in the ABO system. The fact is that the blood group is characterised by the lack of ensitivity of its corpuscles to any of the isoagglutinins. The other blood groups possess agglutinable blood corpuscles. Fig. 1 shows various possibilities of transfusion.

arious possibilities of transfusion.

3. The blood groups are inheried according to Mendelian Law.
The corpuscle characteristics A and
3 & O not appear in a child unless
they are present in at least one of the
barents. A and B behave as strict
dominants. This helps to solve
the mystery of disputed paternity
tases. Table I below amply
demonstrates the point.

J. BHATTACHARYA

· m

Sir, It is stated in the above article hat "persons of O group blood are considered to have the best teeth". This fact is of interest to us. Will ou pleese disclose the reference egarding the statement?

DR. N. UNNI Futor, Department of Oral Pathology Dental Wing, Medical College, Kerala

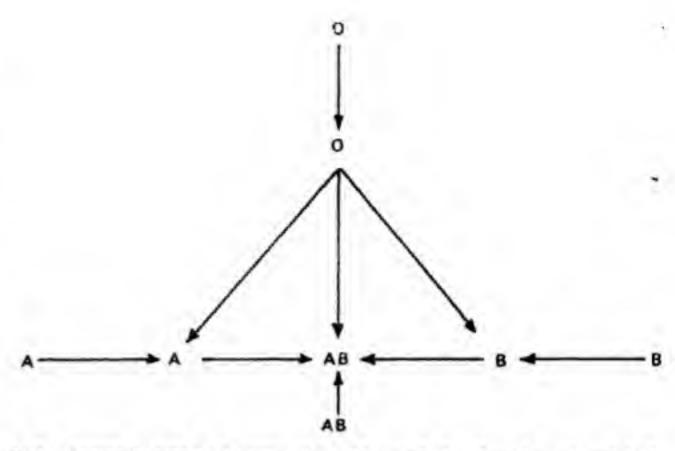


Fig1. Arrows indicate the direction of possible transfusions from donor to recipient

Please consult V. Suk, (1930), Faultless teeth and blood groups (with remarks on decay and care of teeth in whites), Spisylek. Fak. masaryk. University Brno., 125, 1, (Czech).

J. BHATTACHARYA Central Forenic Science Lab., Calcutta-700014

Pets can be dangerous

Sir, The authors of the above article (S.R., April, 1976, 241-45) have not been able to present the article in a scientific way. They have not

explained the role of intermediate and definite hosts in their intimate relation to man.

Certain statements require ref rence and elaboration. I have n idea if oriental sore (Leishman tropica) infects pets. How can it b transmitted to man in the absence sand flea? Again, the statement (pag 243) that "Dirofilaria immiti ha been occasionally reported from man" is controversial as there is n such reference in medical book Will the authors give some authenti references? I think this is also th case with Guinea worm Dracunci lus medinensis which we know occur in man but not in pets. The author should have also stated in wha 'skin tumours' of man Gnathostom spinigerum is found. It seems to be a exaggeration as there are no suc references available.

The authors have not explaine the life cycle of Dibothriocephalulatus and how an infection in per can ever infect man without the intermediate, fish.

One would like to go through the original statements and reference before taking part in any discussion and I think in all articles of your magazine there ought to be some more references, preferably in sequence, as everyone would like to

Table 1

ather	Mother	Possible for child	Impossible for child	Impossible for mother in any mating
	0	O,A	B,AB	AB
1	A	O,A	B,AB	-
	В	O,A,B,AB	, ,	·
	AB	A,B,AB	0	0
	0	O,B	A,AB	AB
	A	O,A,B,AB	_	-
	B	O,B	A,AB .	·
	AB	B,A,AB	0	0
В	0	A,B	O,AB	AB
В	A	A,B,AB	0	_
В	B	A,B,AB	0	-
В	AB	A,B,AB	0	0
0.	0	0	A,B,AB	AB
	A	O,A	B,AB	_
Ci i	В	O,B	A,AB	-
	AB	A,B	O,AB	0

now more than what is given in an ricle.

D.N. TRIPATHI rof. & Head of the Deptt. of Surgery M.K.C.G. Medical College Berhampur, 760004, Orissa

Hybrid seed production

Sir, I would like to make a few omments on Male-sterility and while seed production by Satyendra tumar (S.R. May, 1976).

1. Sorghum is not mainly a crossollinated crop. On the contrary, is mostly a self-pollinated crop with only 5%-15% out crossing also called often cross-pollinated rop—this group includes important rops like pigeon pea and cotton).

- 2. When subjected to chemicals and radiations, there will be gross bromosome structural changes which often result not only in male-terility but also in female sterility. With chemical mutagens it is possible that one could get point mutations without drastically affecting the rest of the system. A male-sterile gene ms7) has been induced in sorghum which is inherited as a simple recesive gene and is extensively used in leveloping sorghum populations.
- Hybrid vigour in bajra has been and is being exploited to the fullest extent possible.
- 4. Symbol 'R' would have been

better used for restorer line instead of 'A' which is used for naming a cytoplasmic male-sterile line. It is better to use known terminology to avoid confusion.

K.V. : AMAIAH

Research Associate

Sorghum B eeding

ICRISAT, Hyderabad

Male goot gives milk

Dear Sir, The photographs (Fig. 1 and Fig. 2) show the testes, penis and mammary glands of a goat. The animal was observed by us in a village near Pauri (Distt. Pauri Garhwal, U.P.) on Sept. 30, 1976. The goat appeared to be male, but the observation of external sexual organs revealed a bewildering sight, i.e., thoroughly well developed mammary glands with teats. And the more interesting thing was that it gave milk, about 200 ml in a day.

We came to know that the goat also performed successfully the sexual function of a male. It is a well known fact that milk is produced in females only after fertilization and parturition. But, in this case it has not produced any osffpring so far.

We have taken the milk sample of the goat to our laboratory for analysis. We are also trying to acquire the goat for extensive studies.

In the meanwhile, we would welcome clarification of this pheno-



Ple. 1



Pig. 2

menon from experts.

J.P. BHATT, & G.C. MISHIN,

Deptt. of Chemistr,

Birla Constituent College

(Garhwal University

Srinaga

(U.P.

CORRIGENDUM

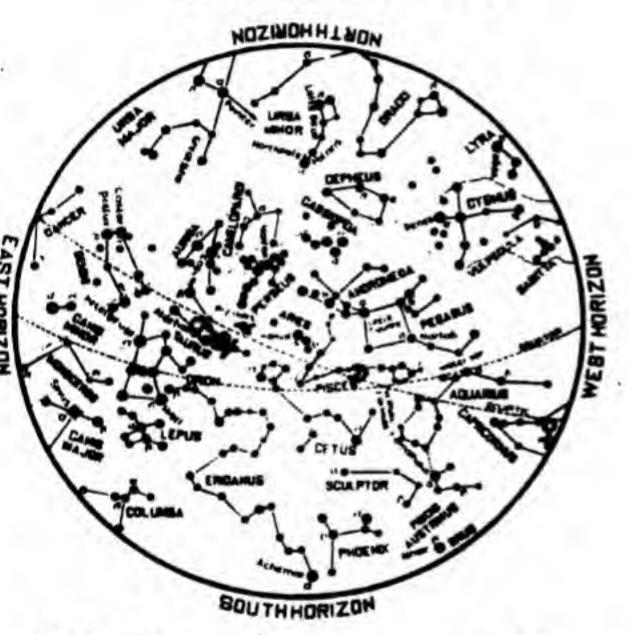
In Science Wheelword puzzle (S. R, August 76), read the clue no. 3 (The Rim) as "the other name for word-blindness" for "The other name for blindness"

In Letters (S.R, October 1976), the references quoted in Dangerous pets are as follows:

- 1. Brit. Journ. Clin. Pract. 29 Aug. 75. p. 217
- 2. Med. Dig. Vol. 21, Jan. 76, pp. 31-32

Planets and their positions

DECEMBER 1976



PLANETS MADATUDES MOON

PLANETS MADATUDES MOON

PLANETS MADATUDES MOON

PLANETS

PLANETS

MOON

FIRST QUARTER 28TH

The moon

I 11-45 p.m. and new moon on lst at 7-38 a.m. I.S.T. The moon asses about a degree south of upiter on 5th, six degrees south of

Saturn in the early hours of 12th, about six degrees north of Mercury on 22nd and seven degrees north of Venus in the evening of 24th. The lunar crescent becomes first visible after the new moon day in the evening of 22nd. The moon is at apogee or

farthest from the earth on 3rd an again on 31st and at perigee on nearest to it on 19th.

The sun is at the winter solstice of 21st.

The planets

Mercury (Budha), an evening states about an hour after sunset during the month. It is at the greater eastern elongation of about 2 degrees from the sun on 20th and becomes retrograde on 28th. I moves from Scorpio (Vrischika) to Sagittarius (Dhanus). Its visual magin tude varies from — 0.5 to +1.1.

Venus (Sukra), an evening starsets about three hours after sunse during the month. It moves from Sagittarius (Dhanus) to Aquariu (Kumbha) through Capricor (Makara). Its visual magnitude about — 3.7.

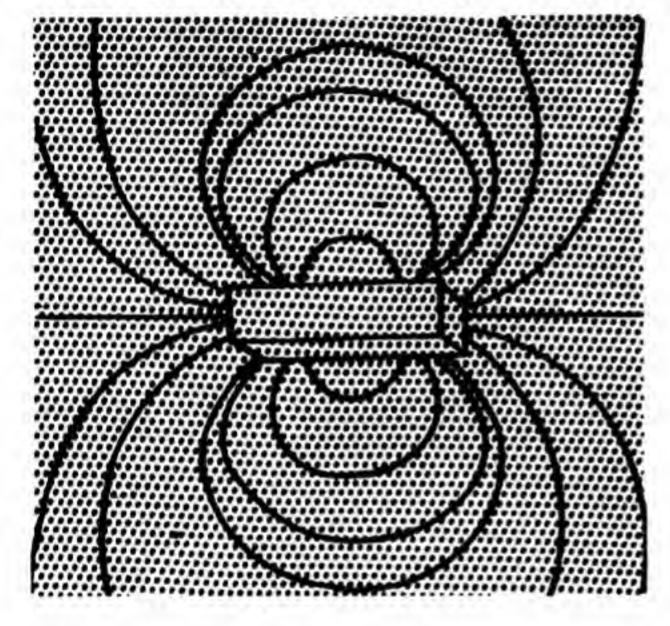
Mars (Mangala) is too near the sun to be visible during the month It moves from Scorpio (Vrishika) to Sagittarius (Dhanus).

Jupiter (Brihaspati), visible in the evening sky, sets about one and half hours before sunrise during the first half of the month and about three hours before it during the second half. It moves from Taurus (Vrishato Aries (Mesha) by retrograd motion. Its visual magnitude is about — 2.3.

Saturn (Sani), visible in the morning sky, rises about two and a half hour before local midnight during the first half of the month and about three and a half hours before it during the second half. It is in Cance (Karkata). Its visual magnitude is about +0.3.

(Source: Nautical Almanac Unit of the Meteorological Office, Alipore Calcutta-27).

WHATIS AFIELD?



The field concept slowly over shadowed other fundamenta physical concepts and i mo dern physics the electromagne tic field is today viewed as real

URING the first quarter of the twentieth century many reolutionary theories were introduced nto physics that shattered the ld conventional ideas. Inevitably, ome fresh concepts emerged in heir place which added a new imension to the picture of eality. The notion of field, preiously represented as the lines of orces, also changed its meaning and ow plays a unique role in modern hysics. Fields are no longer rearded as a convenient tool of the hysical theories but a basic entity nderlying all events in the world. The idea of field stems from the earch for something constant and ternal amidst the world of change nd decay. Early Greek atomists,

Leucippus and Democritus, held the view that matter is an ultimate outcome of the combination and dissociation of atoms. In the philosophy of Aristotle, matter in itself was not believed to be a reality but a mere possibility or 'potentia'. He introduced a vague intermediary 'form' by means of which matter passes into real existence. In other words, he thought of matter as an abstract substratum pervading all space endowed with the possibility of being turned into an actuality by the impelling force of 'form'. Democritus, on the other hand, took matter as the continuous ultimate substance and attributed to it two distinct features of indefinite divisibility and extensibility. He set off the train of idealistic thinking and maintaine that the minute particles of matte by virtue of their movement are reponsible for all the existing events i the universe.

Newton, however, under instinctive compulsion, felt the need of something static and all-pervading which he symbolised in his theory of gravitation. The law of gravitation is often thought to entail the force of gravitation acts instantaneously without any intermediate agent of transmission. Although the proposition seems to diverge from the early trend, an inspection depth shows that it is not much different from the idea of mutual contained in the preferred by the previous atomists.

For the atoms to sustain their discreteness, it is essential to endow them with forces that keep them apart and avoid their absolute merger. In case the absolute contact of atoms is not possible, the idea of action-at-a-distance without being completely ruled out, simply reduces to close-rangeaction. To resolve this dilemma it was later on contemplated a necessity to introduce the concept of a field.

Abolition of force

With the advent of quantum physics the Newtonian concept of force underwent a drastic change. In the Newtonian system, in absence of any external influence, bodies are expected to move in straight lines with a uniform velocity; if they deviate from their straight line movement, their change of motion is ascribed to a 'force'. In classical mechanics, force is uniquely related to the acceleration of a body at a particular moment and at a specific point in space. But in the world of elementary particles not only the acceleration but even the velocity at a definite point is devoid of any meaning. Take, for example, the motion of an electron around the nucleus of an atom. Although it moves in space in time, it can neither be thought of as a simple tiny sphere nor we can visualize its motion as a translation in space along a trajectory. What is more, we cannot directly measure the force of interaction between the electron and the nucleus by any mechanical device howsoever small. In fact, it is not possible using the classical concept of force, to describe the precise ineraction not only of a large multiude of ultra-small particles but even of individual ones.

On the cosmic scale, the Newtonian point of view was superseded by Einstein's theory of relativity. The Newtonian theory, in addition to action-at-a-distance, brought forth we novel changes in the manner of

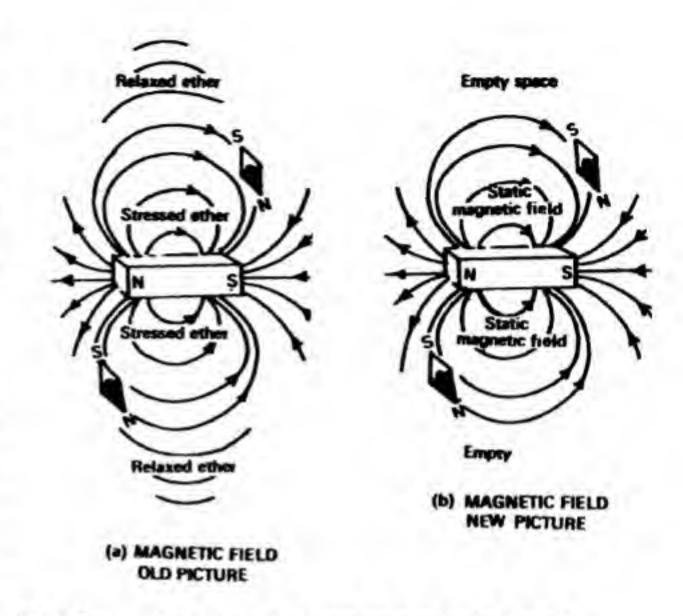


Fig. 1. Comparison between the pre-Einstein and past-Einstein views of

thinking. The first imaginative stroke tried to dispel the notion that the direction of gravitation is always, and in essence, towards 'downwards', i.e., the centre of the earth. Secondly, the sense of orbital motion of a celestial body around a central object with uniform velocity is different from that applied to the motion of bodies under no forces. It implies that the motion of a body in this case is continually being set off the straight track towards the centre of the circle, which essentially needs a force to pull it towards the central Newton, therefore, felt object. necessary to assume that the planets are drawn to the sun by a force known as gravitation.

But, today, the old geometrical concept of 'straight lines' has changed. In fact, there are no straight lines in the usual sense of the term. There are 'geodesics', that indicate the curves of shortest distance between two points but they involve both time as well as space. Everything in the universe moves in a geodesic according to the law of least

action. It means that, owing to the nature of the region in its vicinity, a body takes the easiest course to follow. So it can be concluded that the planets move round the sun not because they are pulled by any 'force' but as it is the easiest thing for them to do. In Einsteinian scheme of things, to treat gravitation as a 'force' exerting an influence on the planets that makes them move round the sun is a fault. The presumed necessity of ascribing gravitation to a force is an outcome of our refuctance to give up Euclidean geometry in any event. In the theory of relativity, Euclidean geometry failed to hold its ground and with it the Newtonian definition of force has to be relinquished. The revised version of Newton's first law of motion may read as "bodies undisturbed by forces travel along geodesics of Einstein's space-time". This definition can account for the motion of the planets around the sun without any reference to the force of gravity.

However, we find it hard on our

part to get rid of our old convicions and wish to think in line with he long-retained notions of Eucidean geometry. If we suppose our pace to be Euclidean, which in fact s not, we shall find, for example, hat the measurements of intervals are not in agreement with the observational results. It is reasonable to suppose that these results conform to an abstract non-Euclidean geometry applicable to the coordinate systems of the so-called test-bodies. For an agency that brings about this discrepancy we use in a wider sense the term 'field of force'. We can therefore say that "the field of force" represents the discrepancy between the natural geometry of a coordinate system and the abstract geometry arbitrarily ascribed to it. So, the new gravitational equations like Maxwell's equations become structure laws, i.e., they connect events which happen at a particular point of space and time with events which will come to pass a short while later in the neighbourhood, and serve as the expressions of the gravitational field changes. To be more precise, just as the Maxwell's laws describe the changes of the electromagnetic field, the new gravitational laws describe the changes in the gravitational fields.

Foundation of fields

We have seen how impossible it is to explain physical realities from the mechanical point of view, assuming that simple forces are at work between immutable particles. Michael Faraday (1834) and Clark Maxwell (1879) for the first time attempted to get rid of action-at-a-distance and envisioned the actual mechanism of electromagnetic forces. They were, however, reluctant to give up the mechanical motion of electromagnetic phenomena. Assuming that space is filled with an all-pervading medium, called ether, they tried to reduce all electromagnetic phenomena to mechanical motions in ether. But in

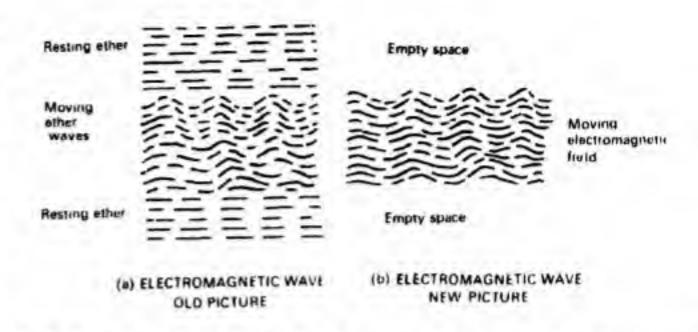


Fig. 2. Comparison between the pre-Einstein and post-Einstein views of an electromagnetic wave

the light of further investigation, this hypothetical medium turned out to be elusive and was finally buried by Einstein's theory of relativity (Figs. 1 and 2). After the futility of ether was proved, it transpired that it was totally impossible not only to build up a mechanics of ether but even to detect any motion with respect to it. The most remarkable aspect of this process was that Maxwell's elegant mathematical formulations remained intact, but the meaning of the terms 'electric field' and 'magnetic field' became different.

In view of the non-existence of an 'universal fluid', viz., ether, lines of forces no more signify invisible 'strings' acting between material particles but they represent the distribution of a field in space. The new field theory claims that to understand the action between two charges it is not necessary to describe the charges themselves, but the field existing between them. The idea of field gradually grew up in strength to such an extent that it deprived matter of its former supremacy as the u'timate reality of the universe. The emergence of field as a new real ity was taken to be an event of vital importance in physics. The field concept slowly overshadowed other fundamental physical concepts and it is no wonder that in modern physics the electromagnetic field is today viewed as real.

After discarding the mechanical viewpoint, it was found that field concepts are most infallible in the realm of electromagnetic phenomena. The electromagnetic laws were weaved into structural forms-the forms which connect any two events in spatio-temporal perspective (i.e., in four dimensional space-time continuum) taking place in close proximity to each other. These structural formulations are invariant with respect to the Lorentz transformations and therefore, are compatible with the special theory of relativity. Further, the development of general theory of relativity modified the gravitational laws into structural forms giving a succinct account of the gravitational field between material particles. It is not far to see that Maxwell's equations may also be easily generalized so that like the gravitational equation of the genera theory of relativity they could fi into any coordinate system.

Matter and field

In the long run we are left with two realities: matter and field. Recent developments in physics demand that we have to preserve both the concepts to deal with the events whether they take place inside the tiny atoms or in the vast interstellar space. But it is worth pondering a to why one should regard matter and field as two distinct and different alities? We can think of an ultra nall bit of matter having a sharp oundary where its surface ends and s gravitational field begins. We an imagine in a naive manner that ere is an abrupt cut-off between ne extension of matter and the region f field. It is difficult to discern ne physical characteristics which raw the line between matter and eld. In pre-relativity trend of hinking, one could have easily asumed that matter has mass and ield is devoid of any mass-matter ignifies mass whereas field displays nergy. But the theory of relativity ells us that matter and energy being nterconvertible, there is no qualitaive difference between them. We now that matter is a concentrated orm of energy and energy is a tenuous form of matter. It is, therefore, intenable to distinguish matter and ield in terms of mass and energy. We can rather think of matter where he enormous concentration of energy occurs and of field where the amassnent of energy is extremely attenuatd. Our argument suggests that it is inreasonable to regard matter and ield as two unrelated and qualitatiely different entities. In fact, it is mpossible to draw a line of demarcation between the two and to trace he point where matter ceases to exist and field comes into play.

The division of physical reality nto matter and field seems to be pased on some vague grounds particularly in the light of the equivalence of mass and energy. The situation became more piquant when it was further found that the electromagnetic laws and the laws of gravitation break down in the domain of highly concentrated energy, i.e., where an electric charge or a material particle s present. On the other hand, it is hardly possible to deal with the physical problems by taking only the matter concept into account. The crux of the question is to get he electromagnetic equations and he gravitational laws slightly modi-

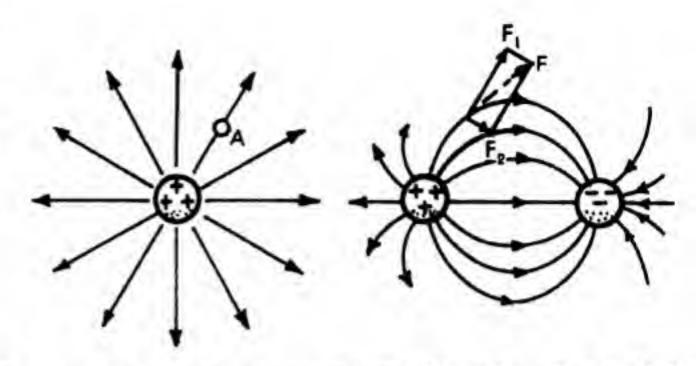


Fig. 3. The electric lines of force showing the electric field around charged bodies. The total force on a test charge A is the vector F of the forces, F, and F,

fied, so as to hold good in all space even where the concentration of energy is high. If the concept of matter alone cannot do, it would be better to reject it and build physics based on pure fields. In that case, instead of taking matter as the culmination of energy, we may view it as a province of space where the field is utterly potent. It would be better to begin with the field as the only reality and express the laws of electricity, magnetism and gravitation in such a manner that they explain every event of nature everywhere and at all times.

Reality of field

The idea of field is worth further analysis. It is a natural corollary of the curvature of space to abandon the concept of absolutely empty space and to regard it as a mainstay not only of the matter but also of the fields. We can think of space as a subtle continuum extending all around in which every interaction manifests itself. No object in space can remain apathetic to the other objects around it, i.e., they are bound to interact and the interaction is just an expression of the field. In fact, a field comes into play at any point in space where a physical event makes itself evident. Therefore, we can conclude that fields are always in existence everywhere, not only beyond the bodies but within them as well, as there even remain unfilled voids inside the minutest particles. In fact, there are fields within the fields. It is of interest to note that the remarkable features of fields are their ubiquity and universality.

It is important to note that field are always at rest with respect to ar observer. In other words, a field produced by the moving charges is o the same nature as that produced by the stationary ones (Fig. 3). We know that any change of the electric field due to the motion of a charge i always associated with a magneti field and vice versa. Now, fo example, if a current is passin through a wire, one may be tempted to ask whether the magnetic field i 'linked' with the wire or with th electrons whose flow is responsible for the field. In this case, we may fin that the velocity of the particles form ing the wire has little to do wit the total electromagnetic effects ob served outside the wire. In facit is the amount of the flowing cur rent that matters and the field ma be regarded 'linked' with neither th wire nor the electrons but with th Therefore, it must b observer. borne in mind that although in som cases the concept of a moving fiel gives the correct solution to a prob lem, to regard the field as moving is however, erroneous. The probler of the reality of fields becomes mor complicated as we do not actuall bserve the fields but their effects nly. In any event, for all practical urposes, the fields do exist, in owsoever subtle form, and they posess energy and momentum like ny other physical entity.

Intangibility of fields is another haracteristic that distinguishes them from matter at large. Fields whether uclear, electromagnetic or gravitational are all impalpable whereas natter is quite tangible and material. The perception of field, however, is not beyond possibility. The motion of any body in space speaks of the ction of the field. In wider persective, for instance, a stone thrown no space can be viewed as the movement of a highly concentrated field in field of extremely low intensity.

In 1900, Max Planck broke a new

round by attributing an atomistic haracter to the electromagnetic eld; and at the turn of the last cenary it was estabished that light is a nanifestation of this typical field. instein's photoelectric effect further dded to it another dimension of fareaching importance, namely, that ne electromagnetic field is quantized nd the quanta of the field are called hotons. It is conceivable that phoons explain the particulate nature f the electromagnetic field. In ubsequent developments, it beame evident that photons, the adiant bits of field. can impart mateal impact on thin metal sheets and ject electrons out of them. Morever, it was discovered that light capable of exerting pressure on odies-implying that the quanta f electromagnetic field possess mass nd behave as an alter ego of partiles of matter.

French physicist Louis de Broglie 1923), on the other hand, put forvard his brilliant theory of mattervaves and tried to bridge the gap between matter and field from the other edge (Fig. 4). According to his theory, an intimate relation exists between waves and particles not only in the case of radiation but also in



Fig. 4. Diffraction of electromagnetic waves showing the wave nature of matter

the case of matter. There is always a wave associated with a moving particle of matter and the particle is governed by the wave in a fashion resembling that in which a photon is kept in control by a wave. As is known, the path of a pencil of monochromatic radiation is determined by the wave theory, while the amount of energy transaction of the same beam is measured by taking recourse to the quantum concept of energy. From this principle it is concluded that though charge, mass and energy of an electron are noticeable in particle form, a beam of electrons could have wave properties. It means, therefore, that matter can behave in a field-like manner.

On account of this dynamic and non-material interpretation of field, the boundaries between matter and energy have become blurred. The points at which the strength of field is enormously large, its material properties become prominent and we envisage them as the particles of matter. For example, according to the field theory an electron can be taken as a microscopic region of electric field where the intensity of the field is greatly enhanced. In case, the concentration of field in a small belt of space becomes disproportionate, the transmission of energy takes place without the points of lowest energy being sharply differentiated from the rest of the field According to the German mathemat cian-physicist Hermann Weyl (1923 the phenomenon happens in exact the same way as a wave move unward across the surface of ser When a stone is thrown into a poo of water the waves go on spreadin in ever-widening circles. If w observe a float on the waves we fin that imitating the particles of water it only oscillates, bobbing up an down, on each side of a certain mea position but does not move alon with the running waves. Similarly we can assume that it is not th actual quanta of field but the di turbance produced by them the passes forward from place to place in the form of waves. It is again this background that Werne Heisenberg (1959) contends the al pervading unified physical field as th ultimate substratum of the univers that possesses simultaneously th attributes of continuousness an discreteness. By virtue of cont nuousness, the unified field embrace all expressions of existence from sup rnova to sub-quantum fragments, an being discrete, it characterises the qu antum nature of elementary particle

The concept of field is indispensable because its measure gives us power t predict the possible behaviour of th particles without needing to know th nature of the sources that produc the fields. The importance of field can best be summed up in the word of Sir Arthur Eddington, "you particle of matter is not fundamenta it has no meaning in itself, what yo are really concerned with is its fieldand matter cannot be thought of apart from its field". It is the field the will carry energy and informatio across the vast distances for all tim to come. Our universe consists of a infinitely large number of events an every event, whether subatomic of stellar, is an expression of the subt interplay of fields. So, it would no be wide off the mark to say that th

cientists believe that ozone which protects life on earth is epleting fast

N.D. KAUSHIKA



IFE on earth exists in innumerable forms. It constitutes that we call the earth's biological nvironment or the biosphere. arth's biosphere is enveloped by, nd owes its existence to, a gaseous nedium called the atmosphere. The ravitational pull of earth is holding he atmosphere around its surface. Consequently, the atmosphere is most ense near earth's surface and beomes thinner at higher altitudes. The west and most dense region of arth's atmosphere is troposphere hich extends upto about 10 km. his region of earth's atmosphere ontrols weather and contains 80 er cent of the total atmospheric as. Above the troposphere are ne other regions of atmosphere:

stratosphere (11 km to 30 km), mesosphere (31 km to 100 km), thermosphere (100 km to 400 km,) and exosphere (above 400 km).

The atmospheric air is a mixture (not a compound) of gases, mainly nitrogen (78.08%), oxygen (20.95%). argon (0.93%) and carbon dioxide (0.03%). Both, the atmospheric air and the surface of the earth, are subjected to radiations from the sun. The consequence of sun's radiations on the upper atmosphere is that certain radiations are absorbed by the atmospheric gases leading to ionization and/or dissociation of gases. In lower mesosphere, the atmospheric oxygen gets dissociated and subsequently combines with molecular oxygen of upper stratosphere thereby

yielding ozone. The reactions are: $O_1 + hv \rightarrow O + O$ + O, + M + O, + N The vertical distribution of ozon extends roughly between 10 kg to 80 km with its peak con centration at 25 km. This region of the upper atmosphere is also calle ozonosphere. The total atmospher ozone contributes only a few mill onth to the total ground level pressur Such constituents that are no mor than a few millionth part of the total atmosphere are known as the mine constituents of the atmosphere. Be sides ozone, the other minor const tuents of the atmosphere are neor helium, kryton, xenon, radon, hy drogen and water vapours. The a mospheric ozone plays a very impo

r. Kaushika teaches physics at Ramjas College, Delhi University

ons of wavelength less than 2900A angstrom, A; I A = 10⁻¹ cm) and partially absorbs wavelengths tween 2900 A and 3500 A. The tmosphere is heated because of this osorption and the earth's biosphere shielded from the lethal radiations.

zone depletion

The supersonic commercial airners fly at ozonospheric cruising
titudes and emit large quantities of
itric oxide (NO). It was in 1971
nat P.J. Curtzen and his collaboraors of National Centre for Atmosheric Research at Boulder, USA,
pointed out that the supersonic
ansport (SST) fleet could add signicant quantities of NO to the normal
zonosphere leading to considerable
eduction in atmospheric ozone
arough the reaction:

he net result is that NO increases ne rate of O, destruction with no hange in the concentration of NO. his catalytic cycle could go on inefinitely, resulting in the destruction f a large number of O₂ molecules. consequently, the intensity of solar Itraviolet radiation that reaches biophere will increase. Several estimates ave been made regarding the extent f ozone depletion by the superonic aircrafts of different types, ifferent fleet sizes, flight times and mission standards. The extent of the ffect is found to be dependent on the ltitude of the flight. If 500 Boeing STs are flown 7 to 8 hours per day or an year at a level of 20 km, their ffect would reduce the global content f ozone by about 10 per cent to 20 er cent. This reduction can pose a onsiderable danger to the biosphere,

tmospheric nuclear explosions

The atmospheric nuclear explos-

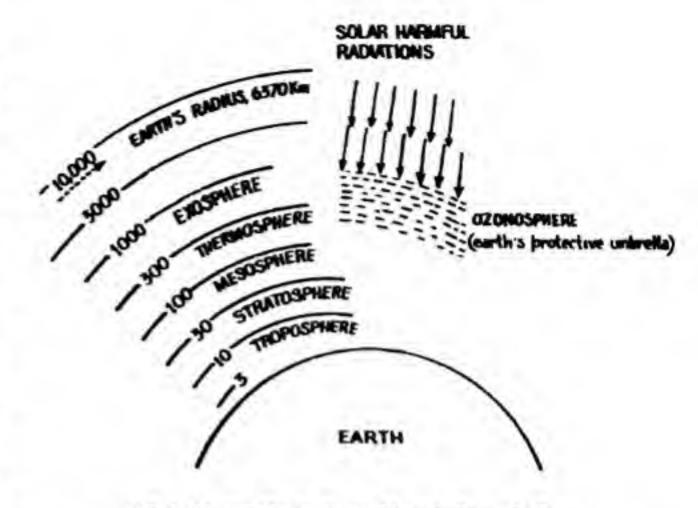


Fig. 1. Atmospheric cause—earth's protective unbrella

ions also add significant quantities of NO in the normal ozonosphere and tend to reduce the atmospheric ozone. However, in underground nuclear explosions practically no addition of NO to the normal ozonosphere is known to take place.

Chloro-fluoromethanes

In modern industry, the fluorochloromethane, mainly diffuredichloromethane (CF₂Cl₂) and fluorochloroform (CFCl₃), are widely used in refrigerators and as propellant gases in aerosol tins. Their widespread use releases CF₂Cl₂ and CFCl₃ into the atmosphere. CF₃Cl₃ and CFCl₄ are inert in lower atmosphere, but are destroyed by the ultraviolet radiation in the ozonosphere. Chlorine is released in the process.

ozone in a catalytic manner;

The time constant for this reaction is also large. It will be 40 years before the full effect will be felt. It is estimated that the total ozone decreases by about 6.5 per cent in this process.

Biospheric consequences

With the depletion of atmospheric ozone there is danger of the increase in the flux of ultraviolet radiation over earth's biosphere. The range of wavelengths particularly affected by the changes in the atmospheric ozone is from 2900A to 3200A. All the known effects of these radiations are harmful. The effects are skin cancer, stoppage of tissue growth. albumen coagulation, and ecological disturbances. Quantitatively, effect of increased UV-radiation on a biological specimen is described by a parameter called the erythemal dose which is:

$$D = \int_{\lambda} E(\lambda). H_{\triangle \lambda} (\lambda). F(\lambda) d\lambda$$

where E (λ) describes the relative response of a biological specimen to UV-radiation as a function of wavelength. $H_{\triangle\lambda}(\lambda)$ is the relevant solar UV-flux. $F(\lambda)$ is the factor increase in UV-flux intensity due to ozone reduction. Calculations show that the erythemal dose increases by about
23 per cent for a 10 per cent increase
in ozone content. The increase in
erythemal dose is related in an almost
linear manner to the increase in skin
cancer (or mortality).

Advanced research in India

The possible effects of pollution at stratospheric levels are of global concern. Consequently, during the past five years the problems of understanding the factors that control the distribution of minor constituents (especially the ozone) in the mesosphere and stratosphere have captivated the attention of atmospheric scientists. In the U.S.A., the Space Shuttle has been planned which will be equipped with a space laboratory. It will have an atmospheric science facility for observing the latitudinal and seasonal distirbution of minor constituents throughout the mesosphere and stratosphere (Scientific Uses of the Space Shuttle, 1974. Report of Summer Study, National Academy of Sciences, Washington, D.C.). In Belgium and Canada, the nalloon borne spectrometer measurenents of NO and NO, profiles in the stratosphere have been made. These measurements have indicated a signiicant pollution of stratosphere by NO and NO, concentrations. In ndia, research in this field of ipplied interest is being carried out it the National Physical Laboratory. New Delhi, under the direction of Or. A.P. Mitra. Recently in November 1975 he pointed out that the hemistry of NOx and HOx combounds may substantially alter the tmospheric ozone layer that protects ife on earth from the harmful solar Itraviolet radiations. The possible hreat to the ozone environment due o ejection of nitric oxide by superonic aircraft and atmospheric nucear explosions and also due to chloine arising from the propellants sed in aerosol cans or emitted by olcanoes, have been a focal point of

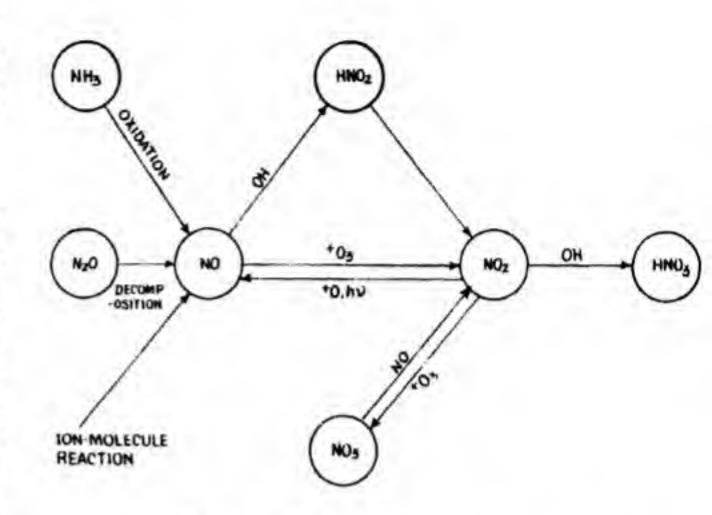


Fig. 2. NO_x chemistry reaction scheme in the atmosphere

Indian studies in the last few years. The problem whether supersonic aircraft at stratospheric altitudes could influence climate, agriculture and human health has received special attention of Indian researchers. The mathematical modelling of stratospheric NOx and ozone profiles is the key step in the investigation of this problem. The major steps of the entire cycle of NOx chemistry affecting stratospheric ozone concentration are: (i) the oxidation of NH, which yields NO; NO is also formed by the decomposition of NO or as a result of ionmolecule reactions; (ii) NO so formed attacks the O, to form NO; (iii) NO, is partly converted back into NO through reaction with O or by photodissociation, and is partly converted into HNO, The reaction ends with a sink in the form of nitric acid, that eventually is assumed to fall to earth as a precipitation. The reaction is:

NO_a + OH + M → HNO₃ + M This cycle of reactions has been computer-simulated for the model stratosphere. The results show that the extent of danger posed by the turn necessitates further investigations on issues like aircraft engindesign and effluents, consequences of effluents, skin cancer, options and predictions, etc.

Further reading

- Crutzen, P.J. (1974), Estimate of possible future ozone reduction from continued use of fluorochloromethanes, Geophys. Res Letters (U.S.A.) 1,205.
- Mitra, A.P. (1975), Chemistry of earth's atmosphere and its implications in radio communication and environmental hazards Proc. Ind. Acad. Sci., Vol. (4) pt A. No. 6, 537.
- Grobecker, A.J., Coroniti, S.C. and Cannon, R.H. (1974), The effects of stratospheric pollution by aircrafts, Rep. of Findings, National Technical Information Service, Springfield, U.S.A.
- Anderson, J.G. and Donahue, T.M. (1975), The neutral composition of the stratosphere and mesosphere, Jour. Atmosph. Terr. Physics (U.K.), Vol. 37 p. 865.



WEED MENACE IN INDIA

Weeds continue to be a menace to cultivation of crops

THE task of increasing food production has many problems. One of the most fromidable is the control of weeds which affect our crops by competing for light, space, water and nutrients. More water and nutrients are required to raise a conne of weeds than to raise a conne of weeds than to raise a tonne of any other crop.

Weeds are also a nuisance to mancind in many other ways. Lantana amara L., which was introduced in ndia as an ornamental plant from Central America, has made many tretches of valuable sal forests iseless. On the slopes of outer Himalaya, it has extended in a big way rendering useless large areas used as pastures. Even cultivated and has been invaded by it and some of the villages are in danger of being aid waste. Besides the colonisation of areas, Lantana is responsible for severe forest fires damaging standing crops. During summer its areas become highly susceptible to fires on account of its dry leaves and twigs. The fire spreads to the boles and crowns of trees through its straggling shoots.

Eupatorium, popularly known as 'communist weed' (a Mexican weed), has spread like wild fire in India in the last few decades. It has become a menace to agricultural lands, road and rail sides, plantations and forest areas. Since 1900 when this weed appeared in India, it has been noted in jungle clearings particularly in places where teak is artificially regenerated. It is a serious menace to the teak saplings depriving them of the much needed sunshine for their growth, and also smothering all vegetation including the ubiquitous Lantana.

Anyone visiting Cochin (Kerala) and taking a boat ride around the port will have noticed that the water surface is practically choked by a leafy growth popularly known as the 'water fern'. This plant, Salvinia molesta (a fern ally of the Salviniaceae), has in the past few years spread all over Kerala's backwaters and hydel project reservoirs. A native of South America, it was carried to other countries notably East Africa and Ceylon and it is suspected to have come to India from Ceylon. It has spread via boats and other human agencies to the backwaters where it is now menacing navigation.

Another floating hydrophytic weed like Salvinia is Eichhornia crassipes, a native of Brazil, which was introduced into India for its beautiful flowers. The plants completely cover the water surface like the cort of a bottle. They pollute drinking water when they die and decay and provide ideal breeding sites for mosquitoes. By invading large area and occurring in dense stands, the impede free movement and use of water in irrigation systems, blockwaterways and also interfere with fish culture.

An obnoxious and pernicious weed Parthenium hysterophorus L., top the seven most dangerous weeds of the world. Today it has sprea throughout India. It came to Indi from South America alongwith whea shipments in 1950s. It is the mos aggressive weed spreading over t cultivated lands, farms, orchard fallow lands, vacant spaces, factorie plantations, sides of streets, alon rivers, streams, around house parks and hopsitals. The magnitud its propagation is ver well seen in South India. Th plant comes up everywhere rapid and crowds out the native vegetation It grows fast, sucks nutrients fro fields and starves the crops. Cow



Eichhornia crassipes

ouffaloes and goats will not touch it! Neither has it any natural enemies ike insects or diseases caused by riruses, bacteria and fungi. This weed s widely reported to have caused complicated skin diseases and is said o be responsible for some deaths. The sollen grains of the weed float freely n air and are reported to have caused llergic diseases like dermatitis, ever and asthma. It causes eczemaoid dermatitis with symptoms like tching around the eyes, which then preads to other areas. There is lso a correlation between the incience of disease and the weed popu-

lation. This weed has been declared by the Karnataka Government as the most dangerous weed of the present time.

Meeting the challenge

Changes in agronomic practices and clearing of forests over the years have often made the environment increasingly viable for weeds. But, what has been gained as a result of the efforts of our scientists and workers should not be lost to weeds. We are now compelled to resort to all available methods to eliminate them.

In eastern India, weed rice (Orys rufipogon) is a serious pest of padd fields. Indian plant breeders one developed some distinctive purple leaved cultivars so that farmers coul distinguish weeds from cultivated ric at an early stage and clear their field by pulling them out. Within few years, however, due to the fre gene flow between the crop and th weed, the weed rice had picked u the purple-leaved character! Suc weeds cannot be easily eradicated b spraying or by biological method because they and the crop plant amongst which they grow belong t the same genus.

The physical and chemical method of control and eradication of weed are usually advocated. According to one estimate, there is an area of about 10,000 acres of plantation and forest infested with Eupatorium is Kerala alone, and weeding costs by conventional methods will amount to Rs. 2 lakhs annually. Another estimate has shown the cost of Lantana eradication by weedicide ranging from Rs. 251 to Rs. 725 per acre.

The total area of the waters in Ghana bird sanctuary, Rajasthan i about 1000 acres out of which 600 acres are badly infested with water hyacinth. In 1960, for the firs time manual labour was employed to eradicate water hyacinth but it was found that with such a large periphery it was a very laborious task. Then 4% solution in water of 2, 4-D Fernoxone was sprayed with mechanical power sprayers. The strength of the solution was ineffective. 6% solution was then used and an area of 329 acres was treated. The total quantity of 2, 4-D Fernoxone used was 1374.1 kg valued at Rs. 9,126. In the spraying operation the cost of petrol and mobil oil is said to have amounted to Rs. 558, and Rs. 5791 was spent on labour. The total expenditure including miscellaneous expenses amounted to Rs. 15,536.



Eupatorium glandulosum

Mechanical removal of Parthenium also out of question. 2,4-D is a sery expensive weedicide to be used or small-leaved weeds like Parthenium. Moreover, weeds have a remendous capacity of developing esistance to weedicides. Further, he weedicides, in turn, pose hazards to humans, livestock and wild life and upset the ecological balance.

Will biological control work for he eradication of weeds? Paulinia ccuminata, a bug, is found to feed in leaves of Salvinia and is a positive neans for the eradication of Salvinia. But look at the case of Lantana. Teleonemia scrupulosa was imported rom Australia to India in 1941 for piological control of Lantana. This oug is a native of Mexico. The mported bug successfully completed ts life cycle on Lantana but the cientists of Forest Research Institute, Dehra Dun, found that when Lantana vas not provided, it attacked conomic and important forest pecies particularly teak infloresences. As a result, the bug was ot released for biological control

of Lantana and all the bugs were destroyed. But in spite of the quarantine conditions, some of the bugs escaped from the F.R.I. Laboratory and an alarming note had to be issued to the foresters to conduct a survey of this bug in their respective localities. One cannot predict that a predator or a pathogen is absolutely specific to some weeds. At some time or the other they lose their specificity and switch their feeding habits to other plants, otherwise the predators have to face extinction along with the weeds they are specific to.

Making use of weeds

There are some who believe that we can control the spread of weeds by utilising them for human welfare. Extraction of a kind of insect repelling essential oil and preparation of manurial ash from Eupatorium have been suggested. It is supposed to contain a high percentage of phosphate and potash and may also be used in the cultivation of potato. Eichhornia is being used as fodder

for cows and buffaloes and also as manure. Several weeds are also used as high protein content roughages. Parthenium is reported to be used as a powerful tonic, febrifuge, analgesic in neuralgia, in dysentery, etc. The plant contains parthenin, a bitter glycoside, which is supposed to be active against cancer. Since the plant is highly resistant to all plant pathogens and insect predators, it would be worthwhile finding out if the extracts of plant could be used on a large commercial scale as pesticide in place of expensive chemical pesticides. The question still remains: how to overcome weed menace and harvest them for successful agriculture and for human welfare.

Forther reading

- Baker, H.G. (1972) Migration of weeds, Taxonomy, Phytogeography and Evolution, D.H. Valentine, London & N.Y.
- George, K. (1968), Herbicidal control of Eupatorium, Indian For., 94(11): 817.
- Joshi, D.P. (1969), Eradication of Lantana camara by lantana bug, Indian For., 95 (3): 152.
- 4. Harkar, A. et al., (1974), Contact dermatitis from Parthenium hysterophorus, Trans. St. John's Hospital Dermatol., 60: 45-53.
- Kelavkar, S.S. (1968), Note on control of Lantana camara and future proposals for its total eradication, Indian For., 94(8): 646.
- Kelkar, G.R. and Ranade, S. (1970), Paper presented at Symposium on problems caused by Parthenium hysterophorus in Maharashtra region of India, Poona, (Ed.) G.S. Chandradas and V.D. Vartak, PANS, 16: 212-214.
- Mohanlal, K.B. (1960), Eradication of Lantana, Eupatorium and other pests, Indian For., 86(8): 482.
- Moni, N.S. and George, M.P. (1959), Indian For., 85: 723-730.



Indian razor blades have yet to attain the excellence of the famous foreign brands

B. K. GUHA S. S. BHATNAGAR

THE razor has undoubtedly been used by the ancient Egyptians nd Romans. It was used in India lso, as is evident from the clean haven figures in the frescoes of lianta. This is not surprising since ncient India produced high quality teel much in demand for sword naking. There are records that lexander the Great introduced having among his soldiers. Since hen, however, the instrument used or shaving has undergone changes n shape and size. The open type ollow ground barber razors are not ncommon even today, although hese have been largely replaced by afety razors which were introduced t the beginning of the 20th century. he safety razor is provided with uards, on both sides of the cutting

edge, which restrain the edge from digging into the skin. Development in razors and improvements in the quality of the blades resulted in a large acceptance of safety razor as the instrument for shaving, and today it is a commodity of everyday use in all parts of the civilized world. Blade manufacture is an important industry in several of the industrially advanced countries of the world. In India too this industry has assumed importance and the commodity produced is exported to Middle-East, South East Asia, Africa and industrially developed countries like the USSR and West Germany.

Carbon steel blades made from high carbon steels, containing about 1.2% carbon, have been used in safety razors since their introduction. However, lately these are being largely replaced by stainless steen blades because of their superior performance in regard to shaving comfort and durability. The increased use of stainless steel blades is doubtless due to their availability at reasonable price and complete replacement of carbon steel blades by them in the near future is quite probable.

The property requirements of the steel for use in the manufacture of safety razor blades are high hardness corrosion resistance and amenability to a coating process by a suitable polymer. The straight chromium hardenable grade of stainless steel is highly suitable for this purpose and now it is being used extensively for blade making.

High hardness is achieved through eat treatment of the steel, which epends on the allotropic transormation of iron and its alloys. on heating to a bright red heat, the teel transforms from its room temerature form called ferrite to ustenite. The latter has a higher olubility for carbon than ferrite. his change in allotropic form, from errite to austenite on heating, as a far reaching significance which as made steel the most important ndustrial material today. The steel n sufficiently fast cooling from high emperature, when it is in austenitic ondition, does not transform into crite but to still another form alled martensite.

Martensite is the hardest form which steel can exist, and the hief object of heat treating a steel is obtain it in this form. However, artensite in this condition is brittle nd it is necessary to soften it. This rocess of softening martensite is chnically known as tempering. In ne hardenable grade of stainless steel sed for blade making, carbon is resent in excess of the solubility mit. Consequently, besides carbon solid solution in austenite, there kist small dispersed undissolved articles of carbide. For this reason hen the austenite is fast cooled to oom temperature, the martensite, so contains these undissolved arbides. In high alloy steels, includig the hardenable stainless steels sed for razor blade making, a part f austenite escapes transformation nd is present as what is called retaind austenite at room temperature. s this austenite is an undesirable onstituent, attempts are made to ransform it into martensite by coolng to sub-zero temperatures in the ange of -50°C to -80°C. Following his treatment, the steel contains only nartensite and carbides and is temered to moderately high temperaures to eliminate the brittleness of nartensite, at the cost of losing some ardness.

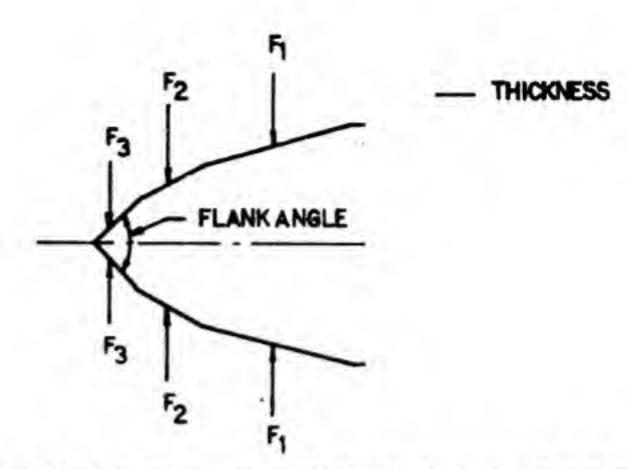


Fig. 1 Section through one edge of a safety razor blade showing the edge facets F_1 F_2 , F_3 , F_4 , and F_5 F_6 and the flank angle

The above describes the outline of the heat treatment adopted for We have not so several steels. far mentioned the particular property conferred by the element chromium, which is an essential constituent of all stainless steels. It has been found that steel must contain at least about 12% chromium to become stainless. This amount of chromium forms an extremely thin and continuous protective layer or film which renders the steel stainless. All stainless razor blade steels therefore contain more 12% chromium. Another than advantage which has gone a long way to make stainless steel suitable for razor blade is the ability of the steel to take a polymer coating which is responsible for the comfort shaving.

Fig. 1 represents a section through one edge of a safety razor blade. It shows that the ultimate edge is formed by the intersection of the two facets (F₂, F₃) which are themselves supported by two pairs of facets (F₃, F₃, and F₁, F₁). The angle between the ultimate facets is called the flank angle. The other important parameter of the razor blade edge is the tip radius shown in Fig. 2. On account of the limitations of the finishing operations, the ulti-

mate edge of the blade is rather ill defined and the tip radius R, a shown in the figure, is taken as measure of sharpness.

It is believed that for maximum comfort of shaving, the force required for the penetration of hair by the blade edge and the movement of the blade edge through the hair after its penetration should be minimum. The force required for the penetration of the hair depends on the tip radius and decreases as the tip radius decreases. However, the force required for the penetration of the hair is small compared to the force required for subsequent movement of the blade edge, and is determined by the flanked edge, and is determined by the flanked

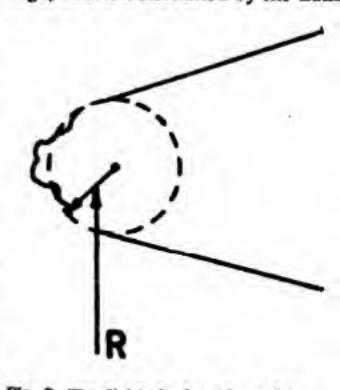


Fig. 2. The finished edge of a safety blade and the tip radius (R)

angle and the coefficient of friction between the hair after penetration and the blade edge. Developments in the razor blade technology have made it possible to coat the edges with a suitable polymer so that the coefficient of friction between the hair (penetrated) and the blade edge surface is greatly reduced. It is evident therefore that low tip radius, low flank angle and low coefficient of friction of the blade edge surface make an ideal blade that gives a comfortable shave and also has a reasonable service life.

There are, however, limits to which the tip radius and the flank angle can be minimised. Beyond a certain minimum, the tip radius causes the edge to behave plastically on application of even a very small load. It has been found that for a well-made blade, the tip radius should be of the order of 1000 to 3000 Angstroms, equivalent to hundred thousandth of one to three centimetres. On the other hand, if the flank angle is redued below a minimum value, the strength of the edge decreases and it becomes prone to failure. For the best results the flank angle should be imited between 19 to 26 degrees. it is apparent, therefore, that for the best properties, as regards the comfort and closeness of shave and the durability of the blade, the optimum values of the tip radius and the lank angle are achieved and the coefficient of friction of the blade edge surface is minimised by a polymer coating process.

As has been indicated earlier, the altimate edge of the blade is rather ll-defined and it ends up in irregular shaped structures (Fig. 2). These structures dig beneath the uppermost issue of the skin, the epidermis, selow which are the sensory nerves. The digging of the epidermis causes after-shave irritation specially when an after-shave lotion is used. To counteract this ill-effect, a vacuum eposition method has been developed in which atoms of a noble metal,

like platinum, are vacuum deposited on the edge to smoothen out the irregularities of the ultimate edge produced by the mechanical sharpening process. The latest development in this field is the deposition of intermetallic compounds, which in addition to smoothening the edges also confer corrosion resistance and hardness to the edge.

Manufacturing safety razor blades is an intricate process. Apart from metallurgical control, it requires the skills of mechanical, electrical and chemical engineers in devising the processing train. Blades are manufactured from strips of 0.10mm thickness of hardenable grade chromium stainless steel containing chromium from 13% to 15% and carbon 0.55% to 0.70%. The manufacturing process consists of punching the strips followed by continuous degreasing, heat-treatment, surface passivation, printing, grinding and honing of the edges, stropping, cleaning and finally coating the edge with a suitable polymer. The heat-treatment consists of gradual heating up of the strip to the austenitising temperature of 1180°C in a three stage continuous furnace (provided with controlled atmosphere), followed by air cooling. The strip is then passed through dry ice to effect the completion of transformation of the retained austenite to martensite. During cooling and sub-zero temperature treatments, the strip is held between pinch rolls to avoid distortion and buckling. The pinch rolls hold only on the central portions of the strip and do not touch the sides so that the edges are not damaged. The strip is then wound and tempered at temperatures between · 100°C and 275°C. Passivation of the surface is carried out in nitric acid bath followed by washing and the strips are then continuously printed. The strip is now fed into precision-controlled grinding machines in which grinding. honing and fine honing are carried out with great accuracy so that the

limits of tolerance. The individual blades are now separated and fin finishing operation on the edge carried out with utmost care by mean of leather discs. The blade edge finally cleaned by ultrasonic agitation and then coated with a polymer. In must, however, be stressed here that the technical details of blade man facture are closely guarded secrets as every producer has to attain the manufacturing perfection through lown research and development.

In India, the open type hollo ground barber razors supplement by imported safety razors as safety razor blades met the requir ments till the beginning of the Secon World War when restrictions we imposed on imports. As a result, safety razor blade of indigenous ma made its first appearance in 194 Since then, due to the untiring effor of the Indian safety razor blade man facturers, the industry has been firmly established and today, apa from meeting the entire requiremen of the country, the industry has b become an important foreign e change earner.

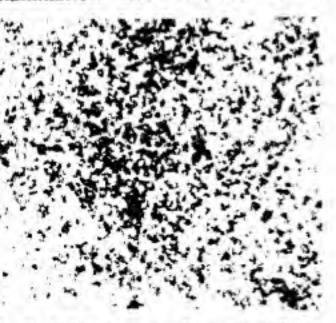
Although there has been sustaine improvement in the quality of stair less steel blades of indigenous mani facture, there still exists room for further improvement so as to attai the excellence of some of the famou foreign brands. With the object of throwing light on the metallurgica factors which might be responsible for the difference in quality of th blades, a project was taken up at th National Metallurgical Laborator the metallurgica to investigate characteristics of some Indian and foreign brands of stainless steel safet razor blades.

The six brands of Indian blade investigated were designated I-1 to I-6 and three foreign blades F-1 to F-3. All the blades had thickness of 0.10mm, except one of foreign origin which was slightly thinner All the blades had dull surface finish

Table 1. Results of chemical analysis (weight in per cent)

rand esignation	Carbon	Chromium	Manga- nese	Silicon	Copper	Molyb- denum	Vanadium
FI	0.68	13.22	0.73	0.35	0.04	0.043	Trace
F2	0.68	13.80	0.63	0.42	0.085	0.055	
F3	0.88	14.36	0.69	0.30	-	14.6	- am
11	0.70	13.3	0.59	0.15	-	9-2	- 10
12	0.76	14.48	0.68	0.35	-	-	*
13	0.72	15.16	0.68	0.32	-	-	1
14	0.77	12.08	0.52	0.53	0.128	0.16	Trace
15	0.66	12.72	0.44	0.45	100	~	
16	0,60	14.33	0.69	0.33	-		17.

xcept one Indian blade which had a right surface. Spectrographic and et chemical analyses were carried ut on the blades to determine the ompositions of the steels used by ne Indian and foreign manufacturers. he results of the analyses, given in able I, show that the stainless steel rips used by both the Indian and oreign manufacturers had similar hemical compositions. Copper and nolybdenum shown in the Table gainst blades F1, F2 and I4 appeared be only residuals and not intenonal additions as the contents of nese elements were of very low order. t is therefore evident that the quality f the famous blades of foreign origin annot be attributed to the chemistry f the steel used. Metallographic xamination also revealed similar



ig. 3. Microstructure of a numple of blade F-1. The light particles of chromium carbide are seen in a background of tempered marteneite (× 1000)

blades. This consisted of particles of carbides dispersed in the tempered martensitic matrix as shown in Fig. 3. Whereas in technical literature superior quality of the blades has been attributed to fine and well distributed carbides, the investigation of foreign and Indian blades revealed, though rarely.

Table 2. Results of microhardness test

		- 1	
	М	HV	
	(1)	681	
0	(iii)	665	
	(i)	665	
1	(ii)	681	
(i	iii)	698	
	(i)	644	
(ii)	649	
G	ni)	634	
1.0	(i)	665	
(ii)	715	
(1	ii)	657	
11	(i)	627	
(ii)	681	
(i	iii)	606	
	(i)	681	
(ie)	649	
(i	iii)	634	
	(i)	673	
- ((ii)	665	
(1	iii)	665	
	(i)	673	
1	(ii)	649	
(iii)	673	
	(i)	707	
10	(iii)	689	
	4		
		20000000000000000000000000000000000000	MHV (i) 681 (ii) 707 (iii) 665 (ii) 681 (iii) 698 (i) 649 (ii) 649 (ii) 657 (i) 657 (i) 657 (ii) 657 (ii) 681 (iii) 665 (ii) 673 (ii) 665 (iii) 673 (ii) 665 (iii) 673 (ii) 673 (ii) 673 (iii) 673

Microhardness of the blades was determined on the flat surfaces of the blades. The results of the test shown in Table 2 indicate similar levels of hardness for both the Indian and foreign blades.

The investigation revealed that both the Indian and foreign blade were made up of strips of stainless ste of similar chemical composition, i.e. 12% to 15% chromium and 0.55%t 0.75° carbon and similar metallo graphic structure and hardness. appears from the investigation tha the initial steps in the manufacturin process, i.e., rolling of the steel to th required thickness and the heat treatment cycle which determines th structure of the steel, were similar in the case of Indian and foreign blades It is apparent therefore that the secre of the superior performance of some of the famous foreign brands of stain less steel blades lies in the refinemen of the finishing steps of the manu facturing process, i.e., grinding, hon ing, stropping, vacuum deposition and polymer coating of the edges.

Research and development work on safety razor blades is continuing in the advanced countries. In our country also we must pursue all our efforts to improve and economise the process of manufacture and develop new technologies in this field to stand out as an able competitor in the export market.

Further reading

- Commodity Study Report on Safety Razor Blades, Indian Institute of Foreign Trade, New Delhi, 1975.
- Guha, B.K., Kulkarni, M.R., Bhatnagar, S.S., An Investigation on the Metallurgical Characteristics of Stainless Steel Safety Razor Blades, NML Tech. J. V. 14, Aug. 1972, p. 105-107.
- New Stainless Steel for Safety Razor Blades, Iron & Steel Vol.38, Oct. 1965, p 505.

MITOCHONDRIAL DNA-A SECOND GENETIC SYSTEM

S. RAMAKRISHNAN

Like ordinary cells, mitochondria also have their own DNAs RNAs and proteins

DEOXYRIBONUCLEIC acid
(DNA) is the genetic material
resent in all plants and animals. It
named nucleic acid because it is
ound in the nucleus and is acidic
the chemical nature. It is made up
the nitrogen-containing bases
denine (A), thymine (T), guanine
(B) and cytosine (C) together with
thosphoric acid and the sugar,
eoxyribose. In cells, it occurs in
the ombination with proteins like hisones under the name nucleoroteins.

DNA is the chief commander and ontroller of all biochemical events and spells out the genetic message. The genetic information is contained the cistrons decided by the sequence of the nitrogen bases A. T. G and C and is transcribed and translated to proteins. It is the sequence of mino acids in a protein which ecides their function, immunologi-

cal properties and species-to-species variation. The sequence of nitrogen bases of the cistrons of DNA decides the sequence of amino acids in different proteins. If due to chemical or radiological effects a change (mutation) has occurred in the sequence of nitrogen bases, it would cause a change in the sequence of amino acids of the protein. Such a change in the amino acid sequence may mean an inherited disease like sickle cell anemia in which out of 146 amino acids only one amino acid has changed due to defective DNA.

Several scientists have won Nobel Prize for their contributions in the field of nucleic acids. They are J.D. Watson, (U.S., 1962); F.H.C. Crick, (England, 1962); L. Pauling, (U.S., 1954); A. Kornberg, (U.S., 1959); S. Ochoa, (U.S., 1959); F. Jacob, (France, 1965); J. Monod, (France, 1965); M.W. Nirenberg, (U.S., 1968); R.W. Holley, (U.S., 1968); and H. Khorana, (U.S., 1968

Nuclear DNA

It is an established fact the DNA is located in the cell nucleu (nuclear DNA-named after its local tion). It cannot come out, as th nuclear membrane is not permeab to DNA. But, remaining in th nucleus, it synthesizes what are calle ribonucleic acids (RNAs) which per form the actual biosynthesis of proteins in the ribosomes attached t the rough endoplasmic reticulum There are three types of RNAs, th transfer (soluble) RNA (tRNA), th ribosomal RNA, and the messenge RNA (mRNA), which are all invo ved in the biosynthesis of proteins.

DNA has three important functions, viz., replication, transcription and translation. Formation of new molecules of daughter DNA is called ranscription is the production of NA by DNA and translation is the uiding of amino acid sequence in roteins.

tructure of nuclear DNA

J.D. Watson, (U.S., 1962) and H.C. Crick, (England, 1962) eluciated the structure of nuclear DNA and got the Nobel Prize for the same. That a double helical structure with wo strands wound round each ther. It is a long molecule with undreds of thousands of nitrogen ases arranged in a particular equence. Having a high molecular eight it is called a biopolymer and as comparatively a poor flux.

litochondrial DNA-A recent

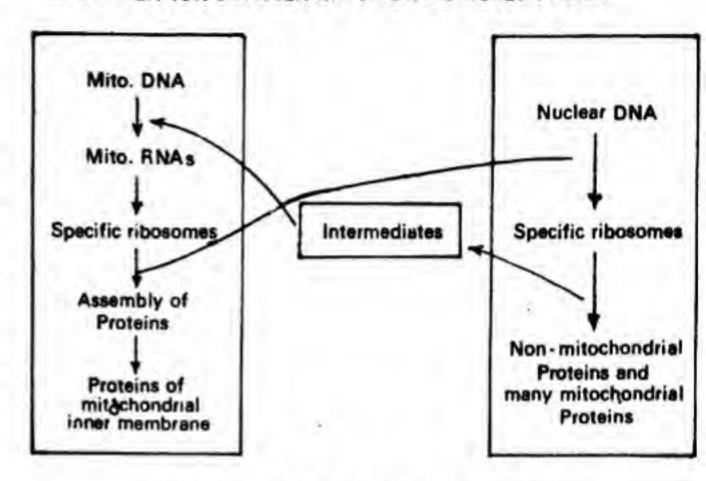
In addition to the occurrence of the DNA in the nucleus constituting the primary genetic machinery, some ecent researches have revealed that nitochondria also contain another upe of DNA (mitochondrial DNA). Mitochondria are organelles inside the cell and are the "power plants" of the cell. As DNA is associated with genetic function, the mitochondrial DNA constitutes a second enetic system of the cell.

The existence of mitochondrial NA has been demonstrated by the echniques of electron microscopy, adio autography and studies on buoyant density of DNA. The uoyant density of DNA varies nearly with its guanine-cytosine ontent and could be determined ccurately by isopyknic caesium hloride centrifugation in an analyical ultra-centrifuge. While in many nammalian species the composition f nitrogen bases of nuclear and nitochondrial DNAs do not differ ignificantly, the mitochondrial DNA f chick is heavier than its nuclear NA, but yeast mitochondrial DNA lighter than its nuclear DNA.

tructure of mito. DNA

The structure of mito.DNA is

INTER RELATION BETWEEN MITO DNA & NUCLEAR DNA



Interrelation between mito. DNA and nuclear DNA

different from that of nuclear DNA. It has circular molecules which may be present as clearly discerned open circles or as twisted supercoiled molecules. In higher animals it is double-stranded with a closed circular configuration. It is supercoiled, covalently linked with no breaks. In several vertebrates and invertebrates it is circular but in higher plants it is linear. Whether linear or circular it is about 5 μ in length. Yeast has both closed, circular and linear molecules.

The significance of circularity of mito. DNA is not yet clear. Circular DNA forms have been observed primarily in bacterial and viral DNA, e.g., polyoma and papilloma virus, E. coli and the replicative forms of X 174 bacteriophage. Circularity may possibly offer stability to this DNA.

The supercoiled mito. DNA from higher organisms are larger than 5μ and are referred to as complex forms of two types. They are: (a) catenated oligomers, and (b) circular oligomers. The catenated oligomers are molecules that consist of two or more interlocked circular duplexes connected to each other like links in a chain.

The circular oligomers are circular duplexes with contour lengths the are multiples of 5 μ monomer.

A length of 5 μ corresponds to about 15,000 base pairs and a mole cular weight of about 10° dalton. It can code for 5000 amino acids (i.e. about 30 peptides of mol. wt. 20,000. An exception to the usual 5 μ length is that of yeast whose mito. DNA has a mol. wt. of 5 × 10° daltons and its circular molecules are 26 μ long.

There appears to be no obvious relation between the composition of mito. and nuclear DNA. Unlike nuclear DNA, mito. DNA is alkallabile. There is fragmentation of mito. DNA within minutes of raising the pH above 12. Heat also causes denaturation. If denaturation is incomplete, renaturation is possible. This renaturation is called "snap-back"

Mitochondria of different tissue have DNA. It was found that ther was no difference between the mito DNA of rat liver and rat kidney.

Replication of mito. DNA

Electron microscopy and radio autography have shown that mito DNA can replicate and product daughter DNA molecules. Synthe sis of mito. DNA in mammalian tissue is 20 to 60 times more rapid than that of nuclear DNA. Also mito. DNA synthesis occurs earlier than nuclear DNA synthesis in a cell.

In contrast to nuclear DNA synthesis, mito. DNA synthesis is not dependent on continuous synthesis of cell sap proteins. When protein synthesis in yeast is stopped by drugs like cyclo-heximidine, nuclear DNA synthesis stops almost completely, while the amount of mito. DNA already synthesized continues to increase.

The enzyme DNA-polymerase for mito.DNA has been identified. There is also mito.RNA. Two RNA pecies have been isolated in animal mitochondria. Molecular hybridization studies have shown that mito. ibosomal RNA is certainly derived from mito. DNA.

unctions of mito.DNA

The function of mito.DNA is protein synthesis like that of nuclear DNA. For this function it uses the ervices of various mito.RNAs. Mito. protein synthesis is different from cell sap protein synthesis; for instance, fuscidic acid inhibits cell ap and bacterial protein synthesis out not mito. protein synthesis. Mito. RNAs are also different from tRNAs of cell sap. RNA-polymerase required for the transcription of mito. DNA has been isolated.

Synthetic system in mito, protein closely related to bacterial system. This is shown by the fact that in east and rat liver, N formyl methinyl tRNA is present in mitochondria ut not in the supernatant of cell

homogenates. N formyl methionyl tRNA is involved in the initiation of synthesis protein in bacteria. Chloramphenicol is a potent inhibitor of bacterial and mitochondrial protein synthesis. This is an illustration to show that antibiotics do affect the protein-synthetic machinery of the host and hence indiscriminate use of antibiotics should be avoided. Cyclo-heximidine inhibits cytoplasmic protein synthesis but has no effect on the synthesis of mitochondrial proteins.

Mito. protein

The unequivocal identification of proteins synthesized within the mito-chondrial directed by messenger RNA transcribed from mito. DNA has not yet been made. Mito. mRNA itself has not been completely characterized yet though its presence is essential in protein biosynthesis.

Most mito. enzyme proteins and many structural protein-components probably derive their amino acid sequence from nuclear genetic machinery (nuclear DNA). They are synthesized on the cytoplasmic ribosomes and subsequently assembled into mitochondria. One mitochondrial protein for which extra mitochondrial synthesis and control have been definitely established is cytochrome c.

Mito. DNA-a second genetic material

The principal, if not the only, proteins synthesized under the direction of mito. DNA are the insoluble lipoproteins of inner membrane that have the properties described for structural proteins. Proteins of outer

mito. membrane, soluble at extractable proteins of the matri and those of the inner mito membras are not synthesised. Mitochondr thus, synthesise only structural pri teins for the inner membrane. could be the real structural prote of the inner membrane or a structure protein required for the assembly the catalytic proteins, say, for th cytochromes. The fractions ident fied as mito. structural proteins as difficult to characterise because their properities of insolubility an their great tendency to aggregate. is still not clear whether there a many different varieties of structure proteins in mitochondria or whether there is only one. In animals th contribution of mito, ribosomes t synthesize mito. protein is 7% t

Turn over

Mito.DNA has been shown to have a rapid turn over in rat tissue. The half-life in heart is about 6. days while that in liver is about 9, days. Turn over in brain is relativel slow.

The role of mito, genetic machiner is equally important as the integrity of mitochondrial membrane has to be maintained at all costs fo the normal biochemical functions of the cell.

Further reading

- Annual Review of Biochemistry
 11, 1972.
- Physiological Reviews, 50, July 1970.
- Proceedings of the National Academy of Sciences, 68, 1972 and 69, 1972.

VHAT IS FIELD? (Continued from page 653)

istory of the universe is written in

urther reading

Eddington, Arthur (1959), Space Time and Gravitation, Harper, Torchbook Edn., U.S.A.

- Einstein, Albert and Infeld, Leopold (1939), The Evolution of Physics, Cambridge University Press, London.
- 3. Heisenberg. Werner (1971),

Physics and Beyond, Harper and Row Publishers, Inc., New York.

 Russell, Bertrand (1960), The ABC of Relativity, New American Library, N.Y., U.S.A.



Island of nuclear stability

THE news that recently struck the scientific world is the discovery scientific world is the discovery three new elements of atomic umbers 116, 124 and 126. Physicists credited for this discovery are .V. Gentry and T.A. Cahill of A.M. Dirac's Laboratory, Florida, .S.A. According to the available ports, they found the new elements minerals. Their half-lives were ound to be in the range ~10° years. his means that once extracted out f the minerals they can be studied onveniently and their chemical proerties evaluated. The most intriuing news is that these two scientists re expecting three more new elements the near future.

The discovery of new elements ecessitates an extrapolation of the dendeleev's periodic classification of lements. It also demands a thorough and elaborate study to explore their articipation in the nuclear energy trogramme as well as in other fields seful to man. Few years ago, a number of theoretical papers appeared indicating that an island of nuclear tability, however, exists around the

elements of atomic numbers 114 to 126. The term "Island of nuclear stability" needs some explanation. It is a well-known fact that in the actinide series elements are more and more unstable as we go down the series beyond Uranium (Table 1). After the actinide series elements are extremely unstable (Table 2). Their half-lives should vary from microseconds to a few seconds as had been found theoretically. But once we reach the elements around atomic numbers 114 to 126, they will be relatively stable so that their physical as well as chemical properties can be studied conveniently. Again, the elements beyond atomic number 126 should be progressively more and more unstable. Thus, there is a zone of stability, the elements on both sides of which are very unstable. This zone is called the "Island of nuclear stability".

Before discussing the stability of the elements, it would be worth mentioning the ways a nucleus can decay (Table 3). Radioactive decay data for the transuranium nuclei show that the α-decay hal lives for elements beyond Curius (Cm) decrease quite sharply whithe decay by spontaneous fission becomes predominant in this region. The combination of α-decay and decay by spontaneous fission responsible for the very low yield of these elements in nuclear reactions. A nuclear reaction that gives rise to the formation of Mendelevium can be illustrated as follows:

But elements with atomic number 101 to 103 are not found in nuclea reactors.

However, the existence of a island of relatively stable nuclei i the region of atomic numbers 11to 126 was predicted in a number of theoretical papers. From she model calculations it was first pro posed that such an island would b centred around the nucleus havin 114 protons and 184 neutrons, i.e. 200 114 (298 is the mass number and 114 is the atomic number). Th US Atomic Energy Commission scientists carried out extensive work in this interesting field. They calcu lated the possible half-lives with respect to spontaneous fission, a decay and B-decay for the super heavy nuclei. These 'calculation were done using two models fo nuclear potential. The first one ba ing the modified harmonic-oscillato single-particle potential, while the second one is the diffuse-surfac single-particle potential.

Using the second model it wa predicted that the nucleus 32411 had the longest half-life of ~100 years, while the first model shower the value to be ~108 years. The also have calculated half-lives o super heavy nuclei in the region Z = 104 to 130 and N = 172 to 19 (Z is the number of protons and) the number of neutrons). The further concluded that it would b better to increase the proton number beyond 114, rather than decreasin the number of neutrons below 184 to get relatively stable nuclei. Th modes of decay for these nuclei hav

Table 1. Actinide elements

89	90	91	92	93
Actinium	Thorium	Protectinium	Uranium	Neptunium
Ac	Th	Pa	U	Np
94	95	96	97	98
Plutonium	Americium	Curium	Berkelium	Californium
Pu	Am	Cm	Bk	a
99	100	101	102	103
Einsteinium	Fermium	Mendele- vium	Nobelium	Lawren- cium
Es	Fm	Md	No	Lw
	Actinium Ac 94 Plutonium Pu 99 Einsteinium	Actinium Thorium Ac Th 94 95 Plutonium Americium Pu Am 99 100 Einsteinium Fermium	Actinium Thorium Protectinium Ac Th Pa 94 95 96 Plutonium Americium Curium Pu Am Cm 99 100 101 Einsteinium Fermium Mendele- vium	Actinium Thorium Protectinium Uranium Ac Th Pa U 94 95 96 97 Plutonium Americium Curium Berkelium Pu Am Cm Bk 99 100 101 102 Einsteinium Fermium Mendele- vium

ements beyond 103 listed below

Table 2

104 Rutherfordium	105 Hafnium	106	
(cka-hafnium)	(eka-tantalum)	(eka-tungsten)	
107	108	109	
eka-rhenium	eka-osmium	eka-iridium	
110	111	112	
cka-platinum	eka-gold	eka-mercury	
	Rutherfordium (eka-hafnium) 107 eka-rhenium 110	Rutherfordium Hafnium (eka-hafnium) (eka-tantalum) 107 108 eka-rhenium eka-osmium 110 111	Rutherfordium Hafnium (eka-hafnium) (eka-tantalum) (eka-tungsten) 107 108 109 eka-rhenium eka-osmium eka-iridium 110 111 112

Table 3

lature of radio- ctive ecay	Change in nuclear mass charge, Z	Change in number A	Character of the process
-decay	Z2	A-4	An a-particle is a system that contains (i) two protons, and (ii) two neutrons
decay	Z+1	A .	Conversion of neutron into proton in the nucleus
t-decay	Z-1	A	Conversion of proton into neutron in the nucleus
lectron capture	Z-1	A	Same as above
pontaneous	Z	Z	Fission of the nucleus usually into two
ssion			fragments of approximately equal mass
	2	2	and charge

Iso been discussed. The predominat mode of decay for nuclei, containing more than 110 protons, and/or a few more than 184 neutrons will be a-emission. For nuclei with Z less than 110, it is β -emission. Once the nucleus with Z = 114 is reached, electron capture is the principal decay mode.

Work is in progress to search for hese super heavy nuclei in nature. Also, with the development of heavyon accelerators, scientists throughout he world are engaged in synthesising them. According to E.O. Fiset and J.R.Nix, it is not possible to go directly to the centre of the island. This group suggested a reaction of the type:

133Th_{se} + ⁷⁶Ge₂₃ → ²⁰⁶122* → ²⁰⁶122 + 4¹n_e

(*means the nucleus is in the excited state)

Here thorium nucleus is bombarded with germanium nucleus, where the product nucleus, 308122, is obtained in a highly excited state. It then emits four neutrons to form 3122.

Should the nucleus **122 survive spontaneous fission, it will decay step-wise by rapid emission of high energy a-particles, with half-lives varying from microseconds to a few seconds. Once the nucleus **114 is reached, the predominant mode of decay will be electron capture and this will lead to new elements. Isotopes of elements 110 and 112 will be the longest lived in a heavy-ion experiment of the above type.

Another possible process is the rapid multiple capture of neutron which is also known as the r-process. In this process, a nucleus absorbs a large number of neutrons very rapidly and then it undergoes successive beta decays to form much heavier and relatively stable nuclei.

Knowledge of physical and chemical properties of elements in this region is essential for their identification. So, scientists worked out the possible properties of these elements by extrapolation in the Mendeleev's periodic classification of elements. Although a large amount of approximation is involved, these predictions might prove useful in the search of super-heavy elements.

The sensational discovery of the elements with atomic numbers 116 124 and 126 with half-lives ~10 years does not tally with the said predictions. However, it is out sincere belief that elements with atomic numbers centred around 11 will be made or discovered. It is hoped that the coming years will set the unveiling of many of their interesting properties which are of immensivalue to the mankind.

PARIMAL K. BHARADWA

Department of Chemistr

Indian Institute of Technolog

Kharagpur, West Benga

Proton radiography

ROTON radiography, a comparatively new technique that is waiting for an early entry to the. pedical field, is similar to neutron adiography (S.R., March, 1972). oth are rays of high energy fundaental particles, but differ in properes from X-rays in that the latter is a electromagnetic wave like light nd heat rays. Neutron rays are ansparent to lead and opaque to ather, rubber and plastics, but roton rays, like X-rays, are opaque lead and bones and transparent flesh and soft tissues. Proton is fundamental particle like neutron nd electron and is present in the uclei of all atoms that constitute atter. Unlike the neutron and ectron it is positively charged. It the bare nucleus of the hydrogen om and is used for changing one ement to the other artificially. Its ze is extremely small, much smaller an a hydrogen atom, and weight is egligible. radiography Proton olds a big promise like X-rays in iagnosing animal ailments in odies.

In the technique of proton radioraphy, high energy protons are
enerated and sent through the parts
f the body like X-rays for diagnosing diseases. It registers a photoraphic image of the body like X-rays
ither on a film or on a computer
inpulse screen. It can reveal successilly the formation of minute cysts
ind changes in soft tissues which
redinarily would not be registered by
the X-rays. Besides, proton ray is
such safer and is less dangerous
han X-rays per unit dose.

X-ray screening has been much riticised in U.S.A. in recent years. op physicians like Dr John C. lailer, a member of the National Cancer Institute and Editor of its journal, and others are of opinion that X-ray radiography actually causes cancer in women screened for its detection. The National Cancer Institute and the American Cancer Society have jointly sponsored a programme in recent years for X-ray screening of women of 35 years or above in the U.S.A. for detecting breast cancer in its early stage, which can be cured without much difficulty. This scheme would handle nearly 300,000 women per year. But Bailer is not in support of the scheme as he argues that X-rays might be causing as many as two cancer cases for every one it detects. He is also of the opinion that X-rays should be replaced by safer proton rays which will not only be safer than X-rays for cancer but has greater detecting power.

It is admitted that X-rays are a highly penetrating form of radiation and hence a good diagnosing tool for detecting diseases inside the body invisible to the naked eye. X-rays are good at defining sharply the contours of bones and hard tissues. They are, however, unable to picture soft tissues successfully, as most of and we have many diseases associated with them X-rays are not very helpful for diagnosing such diseases. Rather proton radiography can see better the soft tissues troubles like those of muscle disorders, strokes cancer, etc., as it has already been used successfully to locate small breast tumours, brain tumours and heart problems in organs removed from the body. There is no reason why the same technique cannot be used to detect such diseases in living bodies.

According to Dr. V. William Steward, in-charge of the programme for developing proton radio graphy in the University of Chicago, it is definitely a new and safer tool in the hands of physicians for looking into the body.

Proton radiography will not only be an excellent tool for detecting breast cancer in women, it will also be able to detect breast cancer in case of males. As male breast cancers are occurring nowadays in good number, the proportion being one male case for every 150 female cases, it would be useful for screening both males and females for an early detection and successful cure.

GOKULANANDA MAHAPATRA Deptt. of Chemistry Ravenshaw College, Cuttack (Orissa

Put water hyacinth to use

WATER hyacinth (Elchhornla crassipes) is known to cause extensive damage to inland waters by competing with the aquatic life and destroying the whole eco-system. It impedes run-off in streams and promotes backwater and flood

cultivable land and renders it unproductive. The water hyacinth "rafts also hinder navigation. Water bodies, polluted with sewage provide an ideal environment for the growth of this weed. Utilising

OVEMBER 1976



Water hyacinth

nitrogen, phosphorus and other nutrients dissolved in water, it proliferates and doubles in bulk in a short period of about two weeks. Because of the menacingly quick spread of the weed, attempts for its destruction have mostly been unsuccessful.

Natural filteration

Dr. B.C. Wolverton of the US National Space Technology Laboratory has found that the weed can be put to a number of uses. It is extremely efficient in absorbing and concentrating dissolved nutrients from water in which it lives. Wolverton has suggested its use in removing nutrients from waste water prior to ts discharge into river.

Apart from nutrients, this weed has also been found to absorb metals and other toxic substances. In aboratory experiments it could remove 0.67 mg of cadmium and 0.5 mg of nickel per gram dry weight in 4 hours. A hectare of weed therefore has the potential of removing 900 gm of cadmium or nickel from about 53,000 gallons of polluted vater in 24 hours. Not only would his process clean toxic effluents from factories but could even be used

to concentrate and reclaim valuable metals.

The weed is also capable of absorbing phenol and phenolic substances commonly found in domestic and industrial sewage and even in drinking water. In laboratory experiments it removed 36 mg of phenol in 72 hours from the water in which it was grown. The phenol absorbed was broken down and utilised fairly rapidly.

The findings of Wolverton can be applied to field conditions with many advantages in India, where vast resources of water hyacinth exist. Since its introduction into this country as an ornamental plant nearly quarter and a half century ago, it has spread so rapidly that it is now found almost in all parts of the country. In West Bengal alone, an estimated 30,000 acres of once clear water surface is reported to have

been infested by this weed.

In India the weed is being used several ways. Farmers in mar parts of Bengal use dry wat hyacinth as fuel. Its ashes a subsequently used as a manur The weed is exceptionally rich potassium and is valuable as potass manure. It is also used as fodd supplement for cattle. In Tam Nadu it is used as feed for buffaloe Milk yield is reported to increase by 10-15 per cent when buffaloes as fed with this weed. The manufature of paper from the dried wee has been attempted in West Benga Pollution abatement agencies India can exploit the natural fil ration capability of this weed for cleaning polluted water bodies.

R. R. KHA Industrial Toxicology Research Centr Lucknow-22600

Eutrophication: cause and control

DDITION of industrial and ur-A ban drainage, agricultural runoff and most organic wastes increase nutrient value of natural waters. The term eutrophication is now used to indicate increased nutrient status of water bodies contributing to an excessive growth of microorganisms, algae, and other aquatic plants. The uncontrolled growth of these forms, particularly in tropical countries, leads to deoxygenation of water and is responsible for fish mortality besides adversely affecting the water supply system. In contrast, the controlled growth of most algae is highly beneficial process which plays an important role in the oxygenation of water and growth of desired aquatic plants.

On the basis of nutrient status

lakes and other surface waters may be divided into two types; oligotro phic and cutrophic. Oligotrophic lakes are relatively unproductive and poor in plant nutrients. In contrast eutrophic lakes possess high amount of nutrients and therefore suppor more aquatic plants. In the begin ing all lakes are oligotrophic bu with passage of time materials re tained by lakes gradually get deposited in the bottom. The bottom sediment is decomposed by bacteria and other microorganisms. The releas sed nutrients initiate the growth of phytoplankton. Death and decom position of these plants recirculate nutrients to support more of phytoplanktons and zooplanktons. Eutrophication is a continuous and natural process by which every lake

Table 1

Parameters	Oligotrophic	Eutrophic
Aquatic plant production	Low	High
Aquatic animal production	Low	High
Aquatic plant nutrient flux	Low	High
Oxygen in the hypolimnion (lower layers of lake)	Present	Absent
Depth of the lake	Deeper	Shallow
Water quality for domestic and industrial uses	Good	Poor

passes from oligotrophic to eutrophic phase through mesotrophic stage. Some of the important characters of oligotrophic and eutrophic lakes are summarized in Table I.

Causes of eutrophication

Depth, size, shape and geographical location of the lake determine the degree of eutrophication. Also biological productivity depends on light, temperature, morphology and concentration of aquatic plant nutrients. Algae and other aquatic plants grow and reproduce in a wide range of temperature. Light is an important external factor which affects production of aquatic plants. Carbon, hydrogen, oxygen, nitrogen and phosphorus are the major ions required for the plant growth besides some trace elements. The most significant aquatic plant nutrients which limit the growth of these plants are nitrogen and phosphorus. It is now well established that nitrogen and phosphorus are the key elements for controlling the aquatic plant growth as they are responsible for the excess growth. The concentration of nitrogen and phosphorus which acually trigger off the growth of plankon depends largely on many other actors. The main sources of the addition of phosphorus and nitrogen to the water bodies are: domesic wastes including sewage: indusrial waste waters; rural and urban frainage; agricultural run off; natual sources; lake sediments; atmospheric sources; and biological nitrogen fixation.

Degree of eutrophication

The advanced stage of eutrophication can be determined by visual observation and often by smell. Since the eutrophication is caused by excessive growth of planktons, the total number of these organisms present at any time can give an idea of the degree of eutrophication. The latter can be measured by Secchi disc transparency (it is a small metal disc painted white and black). The transparency of water is measured by lowering it in water. The eutrophic lakes are less transparent because of high productivity. The volume of algae in graduated centrifuge tube and the chlorophyll content can give the idea of plant growth. The measurement of photosynthetic oxygen by the 'Light and dark bottle experiment' can be used in assessing the degree of eutrophication. The biological productivity can also be measured by using C14 O, as a tracer and its utilization by the aquatic plants. The concentration of nitrogen and phosphorus and the analysis of lake sediment can also provide the nutrient status of the water body.

Significance

The eutrophication of water bodies may have significant effects on domestic, industrial, recreational and agricultural uses of such waters. Water supplied for drinking purposes from such source will be below drinking standard. Some microorganisms produce deadly toxins in the water and various diseases appear in epidemic form. The excessive

Harmful algae

A LGAE are known to be toxic for livestock, horses, cattle, fishes, aquatic animals and even to men. Algal poisons generally produced by water blooms are reported from all over the world. The most commonly abused forms are of blue-green algae; the important among them are Microcystis aeruginosa, Anabaena flos-aquae, Aphanizomenon flos-aquae. Microcystis aeruginosa is known to produce a fast death factor (FDF) which is a water and alcohol soluble polypeptide. Anabaena flos-aquae produces a very fast death factor (VFDF) which kills the experimental organisms within 2-20 minutes. Besides, certain other forms of algae also produce toxins; Prymnesium parvum (Crysophyte) and Gymnodinium venificum Gonyaulax monilata (Dinoflagellate) produce toxins which kill fishes and molluses.

growth of algae will impart colour and odour to the drinking water. These algae clog the filters, retard the water flow and affect waterworks. They also adversely affect the recreational and aesthetic value of the lakes. The most commonly encountered algae of eutrophic waters are Microcystis aeruginosa, Anabaena flosaquae, Aphanizomenon flos-aquae, Oscillatoria, Scenedesmus, certain Eulenoids and Diatoms.

Control

The cutrophication process is a natural sequence of events. It is difficult to halt. Nonetheless, it can definitely be minimised. It can also be reversed temporarily by direct killing of aquatic plants. Usually

copper sulphate and sodium arsenite are employed for killing algae and rooted plants respectively. The use of algicides in recent years is fast replacing metallic compounds. Temporary control of the aquatic plants can be achieved by excluding light from water body for a limited time, but it is not practicable for a large water body.

The most discussed and widely employed method of controlling algae in lakes is of limiting the dissolved nutrients. Phosphorus and nitrogen are essential elements and often limit the plant growth. Nitrogen compounds are much more abundant in soil and water than hose of phosphorus. In addition, many species of blue-green algae, generally associated with eutrophication, fix the atmospheric nitrogen. They not only grow without extraneous nitrogen but also promote the growth of other algae by excreting ome of their nitrogenous compounds. For this reason the nitrogen supply is difficult to limit. The only remaining compound, phosphorus, may be helpful in controlling algal growth.

Various methods are now available for the removal of phosphorus. The most suitable, feasible and readily available methods involve use of chemicals to precipitate additional phosphorus. Such chemicals generally used are alum, lime, iron and sodium aluminate separately or in combination. The methods based on controlling the nutrients include, removal of nitrogen and phosphorus at the source; diversion of nutrient-rich waters from receiving bodies, and dilution of these elements by addition of water.

B.C. RANA
Assistant Professor
Department of Botany
School of Basic Sciences &
Humanities
University of Udaipur, Udaipur

former account for 15% of the products' overall world market value

Several major companies in the United States and Europe have been phasing out their amino acids production on economic considerations the chief of which are the costly resolution of the L-form of the amin acids (the only biologically active form) from racemic mixtures and the fermentative production of some amino acids which involve biochemical engineering often with low yields. However, recent upward shifts in protein prices are making the economic picture of amino acid production look more favourable.

Foodstuffs differ widely in their amino acid composition. For ex ample, soy cake protein contains 1.4% by weight of methionine; corn 2.2%; and polished rice, 3.1% Lysine varies from 2.9% by weigh in corn protein to 6.5% in soy cake and 10% in beef. Similarly, the tryptophan content of corn protein is only 0.6%, but in polished rice it is 2.0%. One way of overcoming the shortage of the non-dispensable amino acids in feed formulations is by adding individual amino acids to compensate for their original deficiency. For example, when Llysine is added to cereals at 2 kg per ton, it raises the protein efficiency ratio—the ratio of weight increase of a guinea pig to protein intake by 30% at a cost increase of only 4%. This approach, according to BEI-CIP, is often cheaper than combin-

World amino-acid demand

THE report published in 1973 by the Paris-based Bureau d'Etudes Industrielles et de Cooperaion of the Institute of Français du Petrole (BEICIP) which examined he economic aspects of amino cids has concluded that the world lemand for several amino acids is ikely to increase sharply in the coming decade and if it does, the resent world capacity for making hem will fall far short of the global eeds. Table 1 taken from the EICIP report will illustrate these oints.

Amino acids involve a 500 million ollars expertise on yearly basis. he most important of their outlets is

in feed enrichment. Pharmaceuticals consume only 2% of annual world consumption. But because the unit price of pharmaceutical grade amino acids is several times higher than that of food-grade acids, the

Table 1

Thousands of metric tons	World capacity	Projected 1980 demand	Potential uses
L-Glutamic acid	200	300-330	Food seasoning, taste enhancement, synthe-
L-Glycine	12	12-15	Pharmaceutical, industrial applications
L-Lysine	16	60-70	Animal feed additive, cereal enrichment
DL-Methionine	92	100-140	Animal feed additive, vegetable oil, synthe- tic protein enrichment
L-Tryptophan	0.1-1	1-5	Animal feed additive, cereal enrichment

ng different foodstuffs whose amino cid content is complementary.

L-glutamic acid is by far the most mportant amino acid in yield. lobal consumption tripled in the ast decade to 200,000 tons in 1972. he BEICIP foresees growth in emand for the amino acid continung at an annual rate of 6% to 8% that by 1980 annual consumpon may be 280,000 to 310,000 meric tons. Besides the use of glutaic acid (as the monosodium salt) enhancement of taste and seasonng of processed foods, its demand expected to increase because of he development of a leather substute in Japan. The latter is made f a fibre base to which is applied a olyamino acid coating whose essenal ingredient is glutamic acid.

Synthetic DL-methionine, produed from acrolein, methyl mercapan, and hydrocyanic acid, is the next amino acid of the largest tonnage. A 29 % average annual growth rate in consumption during the past ten years raised its demand from 65,000 to 70,000 metric tons in 1972.

Although growth in demand for methionine has been remarkable, L-lysine has far outpaced it. Between 1967 and 1972, the consumption of this amino acid increased on an average 43% a year from about 2000 metric tons in 1967 to 15,000 metric tons in 1972. By 1980, the world market for L-lysine as feed supplement is expected to be 40,000 to 45,000 metric tons. Moreover, cereal enrichment could constitute by this time a market for an additional 10,000 to 20,000 metric tons.

Reader, Deptt. of Biochemistry
Culcutta School of Tropical
Medicine, Calcutta-700012

sence or presence of teeth in the adult animal.

Whales

The suborder Mysticeti include whales which are considered to be the giants of the seas. The term whale does not indicate a natural division of the order and sometimes is use to mean the whole species of the Ceta cea, irrespective of their sizes. The are warm-blooded and air breathing Their blubber and fats are prize commercially for use in soap an candle-making industries.

There are three families of whale but only two of them include mos of the commercially important spe cies. They are the right whales o the family Baluenidae, and rorqual and humpback whales of the famil Bala nopteridae. The whales under the family Balaenopteridae have series of baleen plates: they fee on planktonic food obtained b filtration of water through thes plates. Of Balaenopteridae famil five species are recorded in India waters, viz., the Blue whale, Balaen optera musculus; the Fin whale B. physalus; the Pike whale, B. aecu torostrata, B. Indica. and the Se whale, B. borealis. They differ in size colour and habits. Among the fiv species the Blue whale, B. musculus, i the largest living creature in the sea It can attain a length of 30.5 m o more and a weight of 135 tonnes. Ye it feeds on the plankton of the sea

The suborder Odontoceti is characterised by the absence of balcen plates and by the presence of teeth. It comprises seven familie

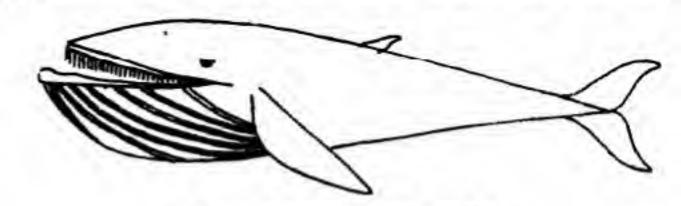
Whales, dolphins and porpoises of the Indian coasts

AMMALS which feed their young with milk secreted by nammary glands rank high in the cale of evolution. Some mammals are adapted themselves to an aquaco mode of life. Among them the etaceans are the commercially important group. They are predominantly marine, though a few of them are preferred freshwater or bracks water environment. The aquacic mode of life has greatly influenced their anatomical features. Almost all of them have fish-like bodies but re distinguishable from the latter by the absence of gills.

In India, however, much attention as not been paid to whales found long the coasts. Occasional strandings of whales have been reported by biologists.

However, dolphins and porpoises occur in good numbers and are caught by fishermen as they cause considerable damage to nets. Besides supplying meat, they can also be of considerable assistance in improving communications in navigation.

The order Cetacea is divided into three suborders: (1) Archaeoceti, exclusively fossil, (2) Mysuceti, and (3) Odontocett, on the basis of ab-



Raleen whale (Balaenoptera musculus)



Fig. 2. 1/o. 7 Schmidt system

means of lamination fluids, pressure and baking. The cementing operation is a simple one and the optical quality of all the elements involved remains intact. Since the operation is a solvent weld, the lamination is as strong and mechanically as homogeneous as a single lens.

Plastics surfaces require protection from casual handling and scratching. Automatic protection is provided when an instrument is athermalized with a glass element as the front lens of a system. Glass windows at the ends of a system are used as an alternate means of scratch protection.

Uses

A number of instruments of different types embodying optical plastics components have been designed and manufactured. Instruments which can be made are listed below.

A variety of sighting telescopes such as 3×75 and 5×100 anti-tank telescopes, 6 x 40 inverting telescope, etc., have been made with optical plastics. The typical 3 x 75 telescope (Fig. 1) is a 3-power fixed-focus telescopic sight mounted on a gun with a fixed reticle to be used for direct anti-tank fire. It has one glass element in the objective assembly. A reticle is placed in a cast mirror erecting system with one mirror between the reticle and the eye piece.

Schmidt systems for television projection have been made with optical plastics elements. The reflector and corrector plate of a f/0.7 Schmidt system (Fig. 2) are made of optical plastics. The mirror is made of glass. The Schmidt corrector plate has a critical aspheric surface which in the past has been especially difficult and time-consuming to generate in glass. The unit is housed in a styrene casting so that temperature compensation for the system is obtained by using the same kind of materialfor mounting that is used for optical plastics elements.

resolving-power of the system is 5 lines per mm at centre of the field.

Offset wedge binocular attachmer (see art. head) is built for an applica tion which requires a double image The previous device for this purpos made use of glass wedge which covered half of each binocular of jective. With such an arrangemen the eye position is extremely critical in order to see both the direct an offset images. In the present attach ment the double image is obtaine by means of prisms with hole through which a direct image may b obtained simultaneously with a de viated image obtained through th prism. Although a slight deteriora tion of image around the holes take place, the instrument is found to b more satisfactory in general than th corresponding glass device. Resolv ing power is 8 seconds at the centi of the field. The instrument is use as a fire control device in directin offset battle practice.

The f/1.6 reflector sight (Fig. ! is designed to be suitable for fixe guns in an aircraft. A spheric reticle is incorporated in this sigh over the entire field the reticle ring are fixed in direction within 1/3 .001 inch. There is no parallax the edge of field. The mounting for this instrument is of cast ma nesium. The optical system is for ded once by means of a mirro The plastics lenses are mounted as unit in plastic sleeve which slips in the metal housing-maintaining th elements in alignment with each other. This arrangement also serve as thermal insulation to redu effect of rapid temperature change

In addition to the above device optical plastic components have been employed in making of the following instruments: 2×32, 3×60, 6×3 and 5×80 Galilean binoculars, 7×3 prism binocular, lenses for ordinary and aerial cameras, parabolic reflectors, rangefinders, periscopes, etc.

(Continued on page 72

Photosynthetic efficiency of the 'source' as well as the storage capacity of the 'sink' are essential prerequisites for the good yield of a crop

DLANTS exhibit a wonderful mechanism of self-reliance by rirtue of the presence of the green igment, chlorophyll. The process of manufacturing food is achieved by using the natural sources of light nd carbon dioxide. Undoubtedly, lants are unique among living rganisms because they manufacure their own food. They possess he most intrinsic mechanism of onverting the solar energy into chenical energy through the process of hotosynthesis, the process in which O, is converted into complex arbon compounds, which ultimately orm the building material for the whole plant body.

Definition of terminologies

Among the plant parts, leaf is the nain site of photosynthesis, although ther green parts of the plant also erform this function to a lesser egree. Briefly, the leaves manuacture food and supply it to diffeent parts of plant body wherever here is need. Leaf is considered as he 'source' of the food, whereas ny part which receives the food is nown as 'sink'. Prof. Harry Beevers Deptt. of Biological Science, Purue University, Lafayette, U.S.A.), efines sink as "that part of the plant here the products of photosynhesis are utilized". For example,



the flowers, fruits and other storage organs like roots (carrot, etc.) are classical examples of sinks. The products of photosynthesis are called 'photosynthates' or 'assimilates'. Translocation' is the mechanism by which the photosynthates are transported from the 'source' to the 'sink'. An intimate relationship exists between the source (leaf) and sink (fruits, grains, etc.) and they exhibit great variations from plant to plant and are interdependent.

importance of the 'source'

There is great diversity in the overall arrangement, size and thickness of leaves among the host of plants distributed in different habitats. The importance of the leaf lies in the fact that it is the receptor organ of the plant responsible for capturing solar energy and converting it into chemical energy. There is a great deal of significance attached to the leaf surface and the incidence of sunlight on the surface in a given area. Two commonly used terms in agricultural field are leaf area index LAI (leaf area/unit land area) and leaf area duration, LAD (leaf area integrated over time) which by the very terminology indicate their importance because they ultimately determine the dry matter production. Plant scientists working on photosynthesis have been giving special attention to the leaf angle as it is an important criterion to study the light interception by a canopy of leaves and hence photosynthetic efficiency. For instance, erect leaf character is considered It would enable larger desirable. sunlit surface when sun angle is So, for maximum photohigh. synthesis erect leaves are the most efficient arrangement. In fact, there is direct evidence of the effect of erect leaves increasing photosynthesis and yield in rice. However, erect leaf is correlated with yield only in cases of high plant density.

Besides the LAI, the total duration when the leaf gets exposed to light also plays a key role in determining photosynthesis as well as grain yield. In wheat, some of the highest yielding varieties exhibited larger green area of the leaf just below the ear head (this leaf is called flag leaf) for longer periods than other varieties. In crops like wheat and barley, the earhead with awns and glumes also remain green for pretty long and so contribute to the grain yield.

Leaf angle and width have been used for selecting high yielding varieties in wheat, barely and oats. Thick leaf is a desirable trait. A positive correlation between leaf thickness and leaf photosynthesis has been shown in rice.

Photosynthesis by other 'sources'

Recent studies on fruit-wall photosynthesis have unravelled yet another avenue in understanding the sourcesink relationship in a better perspective. Much work has been carried out on the chlorophyll content and photosynthetic efficiency of the fruit walls of major pulse crops like gram, peas, etc., and their contribution to the developing seeds. The majority of pulse crops remain green for a long time and hence get longer exposure to light. They are, therefore, important in photosyn-Even sepals, the thetic studies. protective structure of a flower, contribute to seed weight in flax. Some difficulties arise in green pods of some legumes like Bengal gram in that they are 'hidden inside' the canopy of leaves (which are arranged in spreading fashion) so much so that the incidence of light on the pods is greatly minimized. If, by some experimental manipulations, the pods are made to expose better to the light; then there is a possibility of increasing the photosynthetic efficiency of pod walls in such cases. This would amount to changing the

Table 1. Chlorophyll content of fruit wall and leaves in some leguminous crops (pulse crops)

(Chlorophyll, mg per gram fresh weigh

Crop		Leaves	Fruit-wa
Pigeon pea (Red gram)		2.05	0.48
Chick pea (Bengalgram)	•	2.97	1.37
Peas		2.14	0.50
Mung bean (Green gram)		2.52	0.45

(Courtesy: Dr. S.K. Sinha, Water Technology Centre, I.A.R.I., New Delhi)

entire morphological character of the plant. It is worth considering the enormous potentiality of the pod walls as active 'source' during grain development.

From Table 1 it is evident that fruit walls also contain a fairly high chlorophyll content which indicate that they also have a high photosynthetic potential. An assessment of fruit walls for their photosynthetic efficiency is being carried out at the Water Technology Centre I.A.R.I., New Delhi.

Translocation

Once the photosynthates as formed in the leaves ('source'), th next step is their mobilisation different parts of the plant when they are most required. The plan differ in their total number of leave and their arrangements. Neve theless, a specific pattern of ass milate distribution is observed in a cases. Leaves in different position on a plant supply the assimilates t different organs. Lower leave supply assimilates to roots whi upper leaves supply to shoot ape Leaves in the intermediate position supply photosynthates both up an This pattern, however, down.

bject to alterations depending on the temperature, water supply, etc. with change from vegetative to productive stage, the assimilate istribution is also altered. The emand on the assimilates determines the intensity of distribution, or example, a developing fruit will ave a priority demand for assimilates from the adjacent leaves. Il plant parts do not exhibit the intensity of production eaf) can also affect distribution of ssimilates to a particular organ.

Sink'-its significance

considered Having assimilate roduction and distribution, it is ecessary to understand the site here the assimilates reach, i.e. the ink'. Sinks are of different sizes. hey place differential demands on ssimilates from the source. In fact, ery young developing leaves themelves are sinks because they imort photosynthates from older aves for their development. Once ney become self-supporting, they xport assimilates to centres of active rowth like root tips and shoot pices. With the onset of flowering, he pattern of assimilate distribution lso changes. Subsequent fruit evelopment will have further effect n photosynthate movement. There vill always be a shift in the direction f assimilate flow from the source o the sink. At the time of maturity of the crops, storage organs like ruits, grains or tubers-all consilered as potential sinks—will make greater demand for the assimiates.

Although different sinks emerge at different stages of plant growth, all are not efficient sinks. For instance, in grapes, flower is a weak ink but fruits are strong ones. There is also competition between different sinks for assimilate utilisation. A good example is in some pulse crops where the assimilates are diverted more to flowers and developing pods at the expense of root nodules. Experiments have clearly shown that nodules, which are responsible for fixing atmospheric nitrogen in leguminous crops, disintegrate with the onset of flowering, as they are deprived of photosynthates required for maintaining their growth and activity.

Sinks are connected with the source by phloem elements. Translocation of assimilates occurs in the sieve tubes of phloem. Sugars move from the source to the sink. The rate of consumption of sugars at the sink-end determines the direction of movement from the source. If they are not used up at the sink as fast as they are produced at the 'source', then translocation slows down and ultimately sugars accumulate in the leaves. There is thus decline of photosynthetic rate.

Interdependence of 'source' and 'sink'

There is a great interdependence between the source and the sink. The supply from the source and an efficient sink to receive the assimilates are essential for a good yield. The weakness of one can influence greatly the other, so much so that the net result can be a low vield. Their interdependence is obvious. If the assimilates are not translocated to the sinks, the rate of photosynthesis (which represents the activity of the source) is depressed. If new sinks are provided the rate is increased. In potato, if the actively growing tubers are removed, carbohydrates accumulate in the leaves. In wheat, removal of ear has reduced photosynthetic rate of flag leaf by 50%. So also in tomato, the removal of fruits immediately after their onset decreases leaf photosynthesis. When one sink is made ineffective, the assimilates are diverted towards other sinks. Ear removal (primary sink) in wheat enhances the production of tiller (alternate sinks).

A regulatory role has been as cribed to the sink. It is believed to produce certain plant hormone which are translocated to the leave where they enhance the rate o photosynthesis. So, when the sinl is disturbed, it is reflected in poo release of hormones which in turn reduce the photosynthetic activity of the source. It is evident that th source is dependent on the sink fo the stimulation it receives in th form of hormones for assimilat production, whereas sink is depen dent on the source for the assimi lates. So, they are inseparable entitie of plant body.

Another aspect which is wort consideration is the distribution of assimilates to different sinks. This i what is known as partitioning of photosynthates between economi cally useful and non-useful parts In agricultural sciences one come across the two terminologies quit often: 'biological yield' which refer to the total dry matter produce by the entire plant, and 'economi yield' which represents the dr matter accumulated in econom cally useful parts of the plan Fruits, grains, tubers, roots (carro beetroot) and even stems (sugar can are considered 'economic yield The ratio between economic yield an biological yield gives what is know as 'harvest index' which differs from crop to crop. If there is a great distribution of assimilates into eco nomically useful parts, the overa yield can be expected to increas Conversely, any lag in the assimila distribution to these parts can have a deleterious effect on yield. Attemp are being made to work out th harvest index of different crops ar different varieties in a crop grow under varied situations. Table indicates clearly the variations

he harvest index in different crops. Leasons for poor harvest in crops ke pigeon pea are being looked ito.

ield and yield components

The word 'yield' itself is used aguely in many cases. According Prof. R. D. Asana of the ICAR, represents the weight of an rgan or a substance harvested om a plant. Compared to the otal dry matter produced by the lant (biological yield), the weight f a useful part (economic yield) onstitutes only a portion. A strong iteraction exists between photointhesis (source activity), assimilate istribution, translocation and storge of assimilates (sink activity). Ithough all the three determine the ield, the storage capacity of the nk is considered a major limitation grain yield. The main compoents of, say, rice or wheat crop, timately associated with yield are florescence per unit area, spikelets er inflorescence, grains per spikelet, nd grain volume and weight. All ne four components have a great fluence on the yield. These comonents themselves are influenced by nvironmental conditions like light tensity.

able 2. Harvest index of some crops

2.64	Harvest index opproximately)	
road beans (Horse beans)	0.52	
goon pea (Red gram)	0.15	
hick pea (Bengal gram)	0.27	
oybean (Soya)	0.50	
ung bean (Green gram)	0.23	
orghum (Jowar)	0.47	

courtesy: Dr. S. K. Sinha, Water Techology Centre, I.A.R.I., New Delhi)

Environmental influences on source-sink

The change in the environment under which the plant is grown has a marked influence on leaf photosynthesis rate of a given variety. Actually, varietal differences in the rate of leaf photosynthesis may be due to variety-environment interaction. Both temperature and light affect the morphological characters of a leaf and so affect photosynthe-Besides the effect on photosynthesis, temperature also has a complex relationship with spikelet formation, ripening and grain yield. In wheat, a relatively low temperature increases the size of inflorescence, number of spikelet, number of florets per spikelet and grain yield. There are optimum combinations of day and night temperature for each stage of grain development. A higher temperature than the optimum will affect the ripening of grain. Translocation of assimilates from the source to the sink is also greatly affected by temperature. For example, translocation of assimilates from the leaves of sugarcane is dependent on root temperature rather than on shoot temperatures.

Photosynthesis increases with increasing light intensity upto a certain point. In a rice community it increases until 70,000 lux (Lux and foot-candles are units of expression for measuring light intensity. One foot candle = 10.764 lux. For instance, on a bright, sunny day light intensity will be 90,000 to 1,00,000 lux and on a cloudy day 30,000 to 40,000 lux). Grain yield of rice decreases in low light intensity. High light intensity and low temperature are favourable for the formation of large inflorescences with many spikelets in wheat. When rice plants are grown in low light intensity and high nitrogen supply, percentage of sterility increases. there is low light intensity and high

temperature, ripening of grain w be impaired in rice. In fact, a clo positive correlation of rice yield an the total amount of solar radiation during the whole of grain develop ment has been reported. Exper ments carried out at the Central Ric Research Institute, Cuttack, in 197. 74 on some varieties of rice has shown the importance of total sur shine hours for yield. A varie called Vijaya at CRRI, Cuttac yielded 6135 kg/ha during rai season, when the mean daily sur shine hours was 8.3 to 9.1 hours a against only 3674 kg/ha during khar season, the mean daily sunshine hor then being 3.4 to 5 hours. Th duration of sunshine hours the influences the yield. It is the photo synthetic potential that explains th difference, because photosynthesis dependent not only on light intensit but also on its duration. Dr. Yoshida, a renowned Japanese Sc entist working at International Ric Research Institute, Manila, Philip pines, has vividly discussed the aspects in the Annual Review Plant Physiology, 1972.

Light also influences marked the assimilate distribution. Experiments with labelled carbon, 140 have shown reduced movement of assimilates from the needle (leaves) to roots in conifers in localight. Even shades produced be leaves can alter the proportion of assimilate distribution to different sinks. If the photosynthates do no reach the grain due to impairment in their distribution caused by localization, grains remain particulated.

Besides light and temperature water supply too determines photo synthetic rate and assimilate distribution. Reduction in photosynthetic rate and in the rate of assimilate distribution has been reported under water stress.

Another important external factor that affects photosynthesis and yield is carbon dioxide (CO₂). With

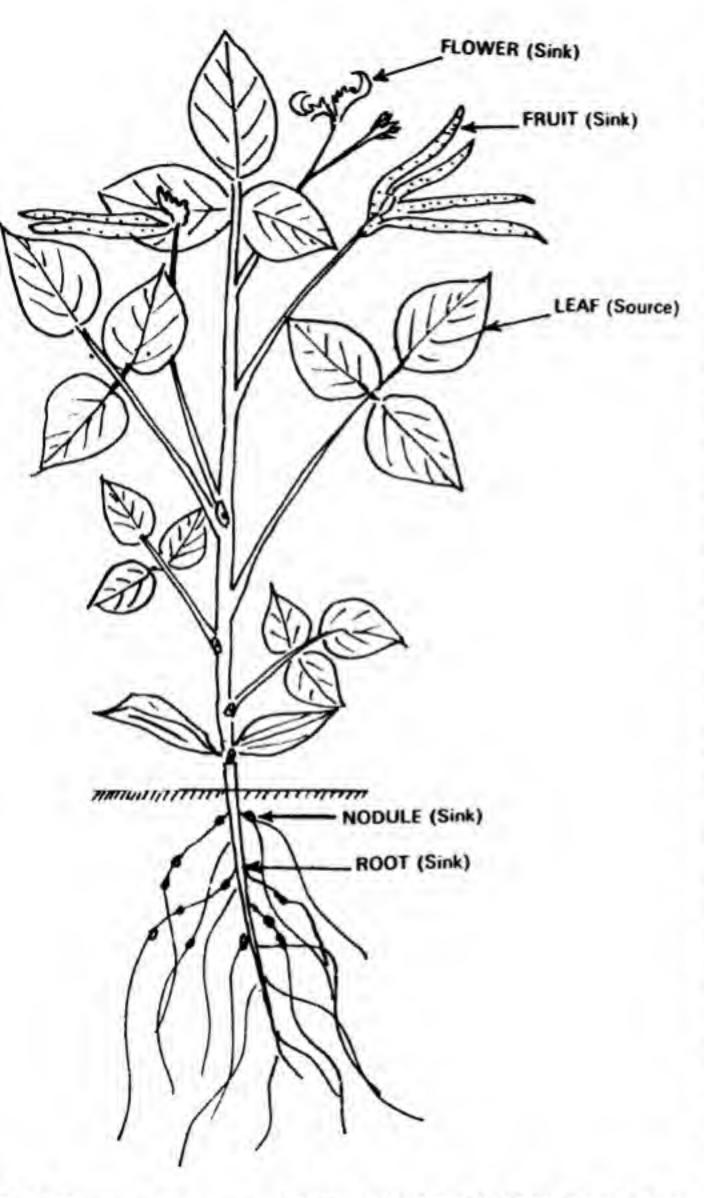


Fig. 1. Diagrammatic representation of 'source-sink relationship' (Plant: Phaseolus aureus Roxburgh: Mung bean). Note the occurrence of different 'sinks', depending on assimilates from the 'source.' Competition between different 'sinks' for assimilates can be visualised. At the pod-development stage fruit becomes stronger sink than the root nodules. Note the nodules degenerating due to deprivation of assimilates from the source

f the atmosphere above 300 ppm., hotosynthetic rate of the leaves lso increased in rice, wheat, barley and soybean. The yield of rice increased from 10 tons/ha to 18.9 tons/ha when CO₂ concentration increased from 300 ppm. to 2400

ppm. Both the grain number at the grain weight are responsible f the increase.

Experimental manipulations

It is now clear that the ultima yield is determined by the effective ness of not only the source and sin but equally by the mechanism translocation of assimilates fro the former to the latter. The thr are interdependent and any distu bance to one factor can have a adverse effect on the other. Expe mental manipulations are possib both at the source and sink levels order to influence the yield. F instance, the reduction of leaf ar (i.e., source size) can be effected removal of a part of the leaf or shedding some leaves so that t remaining leaves can be made mo effective. In this case, sink is ke intact. Results with maize and beobtained by P.F. Wareing et a Department of Botany, Universi College of Wales, Aberystwy (Nature, 223: 1968) showed th partial defoliation increased t photosynthetic rates in the remai ing leaves. So, manipulation the sink is possible by complete partial removal of some sinks. grapes, the cluster of very small berries are removed at an ear stage (this process is called Thinning so that the remaining berries atta the maximum size and marketal yield is improved.

Practical approach

Now, a thorough understanding of source-sink relationship in wide variety of crops is being attempted. Genetic variability yields of many crops is being extended in the light of source-sit relationship. Greater attention being paid to manipulate the source sink aspects to achieve better transfer (Continued on page 733)

Dehydroretinol-a second Dehydroretinol-a second Torm of vitamin A form of vitamin A

Vitamin A, the earliest and one of the most important fat-soluble vitamins, is known to occur in two different forms, viz., vitamin A, or retinol and vitamin A, or dehydroretinol

close interrelationship between the carotenoids (yellow, orange r red pigments found in plants, articularly in leaves and flowers, nd in certain animal tissues) and itamin A regarding their biological ctivity became clear when in 928 B. V. Euler, H. V. Euler and I. Hellstrom working at the Chenical Institute of the University f Stockholm, Sweden, reported that rystalline carotene was effective in uring rats deficient in vitamin A. lowever, it was the British Biohemist, Thomas Moore, who could rst demonstrate that upon feeding nassive amounts of carotenes to ats, the pigments persisted appaently unchanged throughout the ntestinal tract while large quantities f vitamin A were deposited in the ver. He concluded that, "carotene r some part thereof behaves in ivo as a precursor of vitamin A".

Decisive proof of this, however, came later once the chemical structures of B-carotene (I) and vitamin A₁ or retinol (II) (Fig. 1) were established by the brilliant researches of German Chemist P. Karrer and his associates at the Chemical Institute of the University of Zurich, Switzerland in 1930-1932.

An interesting diversion of interest from the main line of research on retinol was opened up in 1937 by the discovery of a new form of the vitamin, characteristic of the liver and other tissues of fresh-water fish and certain amphibians, later on labelled as vitamin A₁ or dehydroretinol (III) (Fig. 1).

In 1931, one of the pioneers of vitamin A research, Prof. R. A. Morton of Liverpool University, Liverpool, U.K. together with I. M. Heilbron and A. E. Gillam of the same Institute observed that fish

liver oils on treatment with Carr Price reagent (antimony trichlorid in chloroform) sometimes showe absorption maxima (the wavelengt at which light absorbs maximum at 635, 645, 656, 680 and 693 nr with a subsidiary maximum at 58 nm in the visible region of the spec trum. This indicated the presence of one or more chromogenic substat ces (substances containing certain groups of atoms the presence which cause characteristic absorp tion of radiation irrespective of th rest of the compound) in such oil Two groups of scientists, R. A. Morton, J. R. Edisbury and C. V Simpkins at the University of Live pool. England on one hand, and I Lederer and V. A. Rosanova at the Vitamin Institute, Leningrad, Russ the other worked, indepen dently on the chromogen respon sible for 693 nm absorption band i

Fig. 1

Carr-Price reaction. However, it vas Morton and his group who in 932 made it sure of a separate entity when they found that 693 nm band vas absent in mammalian liver conentrates which gave only the 620 im band on treatment with Carrrice reagent. Nobel Laureate 3. Wald in the meanwhile in 1937 observed the existence of a new hromogen, different from the comnon retinal (IV) (Fig. 1) that funcions in the eyes of some freshwater ish. Consequently Morton and is group extracted and calculated he ratio of 693 nm and 620 nm oncentration in the liver oils and yes of some of the freshwater fish vith ultraviolet absorption band at 50 nm with inflexions, i.e, smaller ands at 287 and 276 nm (Fig. 2). his interesting aspect that the new hromogen was found invariably in igher concentration in the livers and

eyes of freshwater fish eventually led them to the conclusion that it was entirely a new substance, however, related to vitamin A₁ and named it vitamin A₂ (dehydroretinol).

A thorough investigation of the distribution of the two vitamins has been carried out by many workers of England, Israel and India. It was found that in the freshwater fish the 693:620 nm ratio was about 2:1 while in marine fish it was 0.15:1. However, in spite of the highly variable proportions of vitamins A, and A2 in freshwater fish, certain generalisation can be made. In carnivorous fish, such as the pike (Esox lucius), the pike perch (Lucioperca sandra) and the perch (Perca fluviatilis, the ratio E (693 nm): E(620 nm) is the highest, between 2 and 3. Omnivorous fish such as the bream (Abramis brama).

the carp (Cyprinus carpio) and th tech (Tinca tinca) and the migrator fish like the salmon (Salmo salar the sturgeon (Acipenser sturio), th cel (Anguella vulgaris), the brow brook trout (Salmo fario) and th rainbow trout (Salmo iridens) cor tain comparatively smaller propor tions of vitamin A2. The vitamin A A, ratio shows little variation in given species of fish; it was pract cally independent of the sex and th age of the fish and the country of it origin. Seasonal variations also d not occur. However, as the total o content of the fish shows seasons changes, dilution effects may b discernible. In the same fish th E(693 nm): E (620 nm) ratio is not th same in various parts of the bodyit is usually highest in the liver pyloric caeca and other absorbin surfaces of the gut. In the carp th ratio was 2.3: 3.5 in the retina and 0.5:0.9 in the liver. The halibu showed in E(693): E(620 nm) ratio of 1:6 for the liver fat and 1:19 for the body fat.

In India, some reports are obtained about the retinol and dehydroretino contents of liver oil of freshwate fish. Some of the species are ricl sources of dehydroretinol. R. K Barua and P. G. Nayar of the Department of Chemistry, Gauhat University, Assam (Ind. J. Chem. 2, 254, 1964) could show tha the carnivorous fish have a higher dehydroretinol content than omni vorous or vegetarian fish, while some of the fish studied by them (Hilse ilisa, Pangasium pangasium and Ophicephalus striatus) do not con tain any amount of retinol. Furthe reports have shown that the scale bearing fish with herbivorous habita contain mainly retinol. Moreover among the carnivorous fish the reti nol content is higher in the specie of riverine habitat than those of the lakes and ponds.

Although it is now well established that retinol is formed from

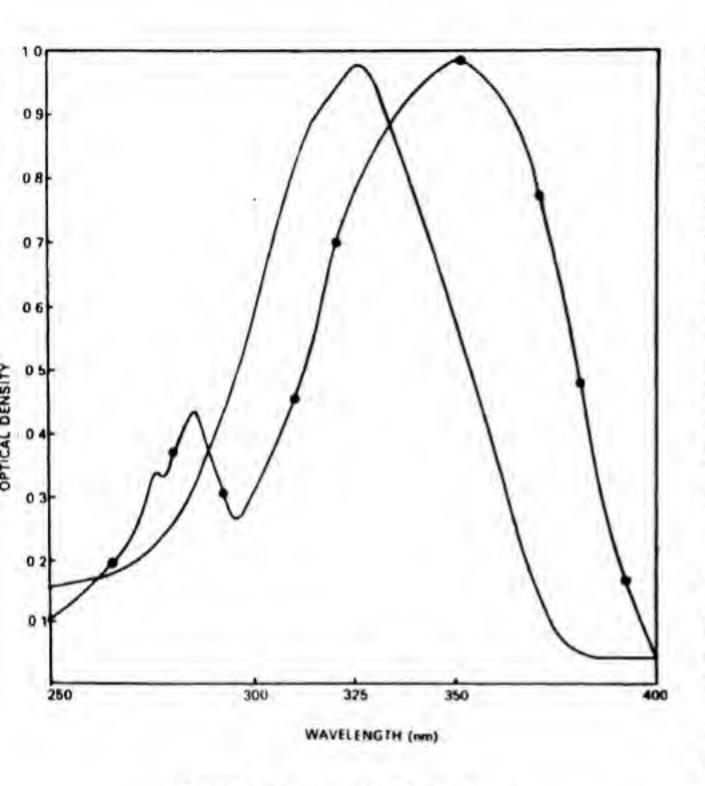


Fig. 2. Absorption spectra of retinol (-)
and dehydroretinol (---)

e provitamins A containing at least ne unsubstituted B-ionone ring, z., B-carotenes, a-carotene, Y-carone, cryptoxanthin, citroxanthin, chinenone, torularhodin, etc. little known about the biogenesis compound. dehydro efore the structure of vitamin A. as proved to be 3-dehydro-vitamin , R. A. Morton and R. H. Greed bserved (Biochem., J., 33, 318, 939) that administration of β -caroene resulted in an increase of oth retinol and dehydroretinol in ome freshwater fish. However, this nding has not been confirmed. ome other reports about the preursor of dehydroretinol have apcared from time to time but the ndings fail to reveal the true origin f dehydroretinol from natural soures. Moreover, almost all the works

carried out on this aspect were indirect, as the experiments were conducted not on fish but on chicks and rats which do not normally contain dehydroretinol in their tissues.

In a recent work with Saccobranchus fossilis as the experimental freshwater fish, A. B. Barua and his coworkers at the Department of Chemistry of the University of Gauhati, Assam could explore for the first time the true biosynthetic pathway of dehydroretinol. It has been shown that Saccobranchus fossilis, a commonly available freshwater fish (Fig. 3a) which was made vitamin A-deficient by being fed on a diet of rice and goat meat (Fig. 3b), cannot convert the orally or subcutaneously administered \$\theta\text{caro-}

tene or zeaxanthin (3, 3'-dihdyroxy B-carotene) into dehydroretinol. On the other hand, lutein (3, 3'-dihydroxy a-carotene) (V) (Fig. 4) or anhydrolutein (3'-4'-didehydro 3hydroxy B-carotene) (VI) (Fig. 4) on administration by either pathway can easily, be converted into dehydroretinol. It was possible to isolate some anhydrolutein after lutein was fed to the vitamin A-depleted S. fossilis as well as the occurrence isolation of anhydrolutein from the liver oil of freshly caught fish. This confirmed the view that lutein can be transformed by the fish into anhydrolutein which is then convetred into dehydroretinol.

There is no report till now about the availability of anhydrolutein in the plant kingdom. The occurrence of anhydrolutein in S. fossilis indicates that the fish can synthesise anhydrolutein only through dietary lutein.

Based on these findings a pathway of the biogenesis of dehydroretinol has been proposed (Fig. 4).

Barua and his coworkers were able to show that dehydroretinol is derived from an entirely new type of precursor, different from the familiar provitamin A carotenoieds, and that occasionally even th hydroxylated carotenoids can serve as precursors for vitamin A-active compounds.

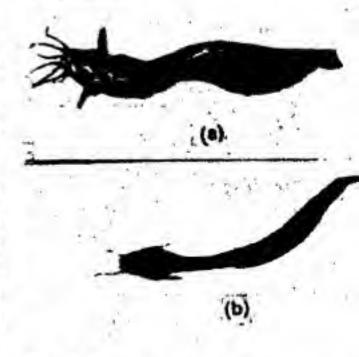


Fig. 3. Succebranchus fossiles (a) freshly caught (b) vitamin A depleted

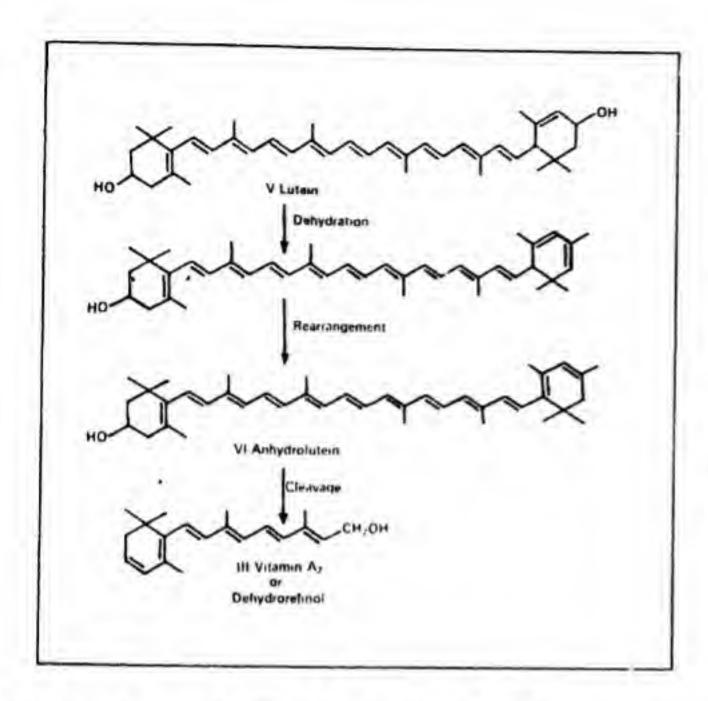


Fig. 4. Possible pathway of formation of dehydroretinol from lutein in Saccobranchus fossilis fish

Further reading

- Moore, T., Vitamin A, Elsevier Amsterdam, 1957.
- Ganguly, J. and Murthy, S.K.
 The Vitamins, Vol. I, Secon-Edition, Academic Press, London & New York, 1967.
- Isler, O., Carotenoids, Birkhause Verlag, Basle and Stuttgart 1971.
- Barua, A.B., Singh, H.T. and Das. R.C.; Brit. J. Nutr., 30 1, 1973.
- Barua, A.B. and Das R.C. Birt. J. Nutr., 33, 319, 1975.
- Isler, O., Carotenoids, Birk hauser Verlag, Basle and Stutt gart, 1871.
- Barua, A.B., Singh, H.T. and Das, R.C.; Brit. J. Nutr., 30 1, 1973.
- Barua, A.B. and Das, R.C.;
 Brit. J. Nutr., 33, 319, 1975.

OPTICAL PLASTICS (Continued from page 720)

Further reading

- Marshall, G.F., Plastic Integral Optics, Optical Spectra, 8, 34 (1974).
- Stockman, D.L. and Shirk, R.A.,
 On the preparation and properties of an optically isotropic
- polymer, Appl. Opt., 5, 863 (1966).
- Jena Synthetic Optics, Jena Review, p. 178 1966/3.
- Plastic fresnel optics and their application in scientific instrument manufacture, Jena Review, p. 287, 1966/5.
- Lamble, J.H. and Dakmouch, E.S., Photoelastic properties of plasticised polymethyl methacrylate in the glassy state, Brit. J. Appl. Phys., 9, 388 (1958).
- Raine, H.C., Plastic glasses, Proc. of London Conference on Optical Instruments, p. 243, 1950.



K.K. TANDON PUSHPINDER KAUF

Science has a tale to tel about tails

them the caudal fin is supported to the notochordal axis which may to straight or upturned or downward directed.

The structure and the development of the caudal fin of aquatic vertibrates has been studied by man workers. The terms protocercal of diphycercal, heterocercal and home cercal indicate the main types of caudal fins in fishes. Modification of these types are many and an quite interesting in themselves. Therefore a brief account of the types is essential to know the functions.

Protocercal or diphycercal In this type of tail fin the notochord axis is straight dividing the tail fit symmetrically, both externally an internally. The fin is supported to fin rays which are either modification neural or haemal spines (e.g., living Agnatha) or by true fin rays mounted on the epurals or hypura (e.g., adult cod). In cods the true

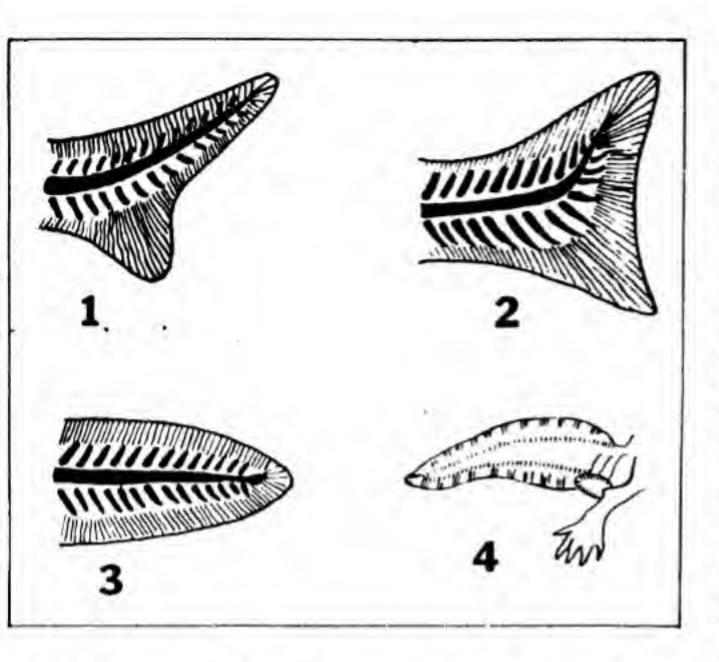
HOW is tail useful to an animal? To understand this aspect, one hould know something of it as occurs in different classes of ertebrates.

The post-anal part of the body is alled the caudal region. It is in his region that the tail or tail fin found. It is a characteristic eature of almost all vertebrates and is typically absent in non-hordates. In adult branchiostomes and in larval urochordates it is upported mainly by notochord, out in vertebrates it is supported by he vertebral column and hence is a part of the axial skelcton. In its

In aquatic forms, due to the presence of myotomes, it serves as the chief propulsive or swimming organ, while in terrestrial forms, including viviparous and oviparous species, it assumes various shapes and functions according to the needs of the body

Fishes

In fishes the tail is surrounded by tail fin or caudal fin and plays an important part in the forward thrust. So it is well developed in many members of the class Pisces. In



Figs. 1. Heterocercal tail fin 2. Homocercal tail fin 3. Protocercal or diphycercal tail fin 4. Tail of triton

audal is reduced and certain dorsal and anal fin elements are fused with . However, in the larval cod, he tail is fundamentally asymnetrical.

Heterocercal. In this type of all fin the notochordal axis is upperned and almost reaches the p of the epichordal lobe of the audal fin. Hence the caudal fin asymmetrical externally as well as a ternally. The hypochordal lobe is rell developed. This is characteristic of elasmobranchs and sturgeons.

Homocercal. This is a modificaion of heterocercal tail in which he notochordal axis stops short but turned upwards with the result hat both the lobes of the caudal in are constituted by the lower or ypochordal lobe of the caudal fin. The epichordal lobe receives support om the epurals which do not, in act, contribute to the formation of the caudal fin. Thus the tail fin is ymmetrical externally but asymmetrical internally. This is characteristic of all the living bony fishes.

In some forms the tail is further modified into: (a) Isocercal or leptocercal, (b) Gephyrocercal, and (c) Pseudocaudal.

Isocercal or leptocercal. In this type of tail fin the lower lobe of the caudal fin is reduced in size and the dorsal and anal fins elongate until a continuous fin fold is reestablished. This is characteristic of rat tails, eels and some blennid fishes.

Gephyrocrecal. In sunfishes the body ends abruptly behind the short high dorsal and ana! fins and is margined by a low, rounded caudal fin with a slightly wavy edge. The supporting elements are derived from dorsal and ventral interspinous bones. This type represents a specialized condition and is found only in unrelated pearl fishes.

Pseudocaudal. In modern lung fishes the caudal fin is formed by the backward growth of dorsal and an elements. At no stage of the linking is there any evidence the heterocercy. Yet it is difficult to believe that this is a true protocercy tail because all the known ancestrally lung fishes possessed clearly heterocercal tails (Norman, 1963).

The lobes of the homocercal to assume different shapes such a lunate or crescentic, forked, emarginate, truncate, rounded, pointed and double emarginate. Each type indicative of the speed of the fise.g., fishes with lunate or cresce tails are fast swimmers and tho with rounded homocercal tail finare slow swimmers. Other categorical in between these extremes.

'Inverted' heterocercal tail jor hypocercal tail fin. In this case the notochordal axis stops short and turned sharply downwards so the both the lobes are developed from the upper part (epichordal lobe), the hypochordal lobe being greatly to duced. It is found in extinct Agnath

A special type of tail fin is four in Trachypterus (Deal fish) in which

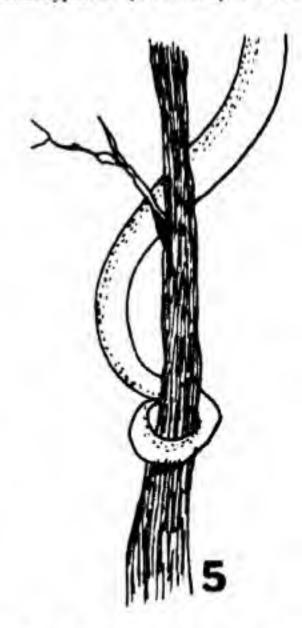


Fig. 5. Prehensile tail of chamaeleon

right angles to the long axis of the body. In the young fish, the rays of hypochordal are sufficiently elongated to form filaments but, later in ontogeny, the rays of hypochordal atrophy. In the adult only the epichordal lobe is left behind.

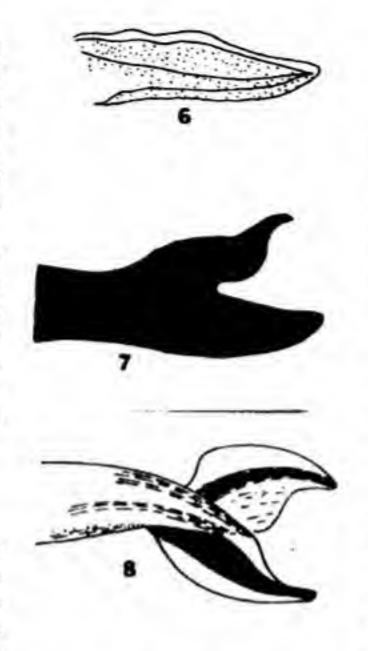
From the evolutionary point of view heterocercal tail (and its modification, the hypocercal tail), is most primitive, indicating that even in earlier fishes or fish-like vertebrates, there was a protocercal tail. Homocercal tail is a recent acquisition.

Amphibians

In amphibians, tails and tail fins are present in the tailed amphibians and the larvae of tail-less amphibians, but never supported by fin rays. In urodeles many caudal vertebrae follow the single sacral vertebrae, each with a small neural arch and a small haemal arch. In anurans, however, all vertebrae posterior to the sacrum are fused into a single solid structure called the urostyle which acts as a counterbalance during the animal's terrestrial locomotion. The tail may be either compressed bearing a tail fin as n Necturus, Proteus, Triton, Siren and Axoloti larva of Ambystoma, etc., or it may be without a tail fin, e.g., dult Amblyostoma and Salamandar. in frogs and toads the tail and a tail in are present only in the larval tages and absent in the adult. Whenever the tail is present it helps n locomotion both on land and in vater.

Reptiles

In contrast to amphibians, all eptiles possess well developed ails. In them the caudal region is of variable length. In most reptiles, he haemal arches are not fused onto he centra but are separate bones alled chevron bones, articulating



Figs. 6. Tail of Axolott larva of Ambiyostoma 7. Tail (in of whale (Balaenoptera rostrata) 8. Tail (in of fresh water dolphin (Platanista gangeuous)

with centra. The tail may either be very short as in tortoises and turtles or long and laterally compressed as in Sphenodon and Varanus or fairly long and tapering as in Calotes, Phrynosoma and Anguis or it may be slender and tapering as in lizards or geckos or it may be slender and tapering as in Draco, but in this form it is not brittle.

In lizards, the phenomenon of autotomy, i.e., breaking a part of the tail is common. In the tail, almost every caudal vertebra has a narrow transverse unossified zone at which it breaks up readily. This mechanism is used for self-defence. When pursued by an enemy or caught by tail, the gecko breaks off its tail, the latter engages the enemy by performing wriggling movements and enables the lizard to escape. After some time a new tail regenerates but lacks vertebrae. In snakes also, the phenomenon of autotomy

can be observed. Actual cases of two tails have been found in lizards

In Chamaeleon the tail is lon cylindrical, tapering and prehensil It is rolled downwards to coil roun the branches for extra grip. Heloderma, popularly named as gila monster or poisonous lizard, it thick and serves as a storehous for fat. Generally, the snakes have a short and tapering or blunt ta as in Errx where it looks like th head. But in Crotalus or ratt snake there is a rattle at the end of the tail. The rattle consists of 10-1 dry horny rings loosely held together It produces a characteristic rattlin sound when the tail is vibrated probably for warning the intrude In the sea and other freshwater snakes the tail is laterally compresse and oar-like for swimming. In cro codiles the tail is large, heavy an compressed and is used for swimming

Birds

True tails in birds are extremely short and stumpy and are known a uropygium. In them the cauda vertebrae are greatly reduced bot in size and number and fused togethe to form pygostyle. This is the skeletal support for the tail feathers and its size is proportional to the size of tail feathers and stress on them The pygostyle bears long tail feather to which the word 'tail' is usually applied. On its upper surface a small papilla, bearing an opening of the oil gland, is situated. The oil secreted by this gland make kiwk feathers waterproof. In tail feathers are absent. In Milvu (pariah kite) the tail is forked In male Pavo (peacock) the tai possesses a long train of numerous gorgeous, erectile, ocellated tai coverts. The tail feathers in birds are splendidly coloured.

Mammals

Most mammals have well developed tails, but this is lacking in the adults of all the higher primates

audal vertebrae, usually 3-5 in man, and fifty or so in scaly ant-eater. Rarely, a fleshy tail extends a few niches beyond the caudal vertebrae. Whether or not an external tail is resent, the muscles which move the ails of other mammals are present in the primates.

In mammals there are three sacral ertebrae which are fused to the elvic girdle, but in some species here are as many as seven or eight. ollowing these are the small caudal ertebrae articulating at least anteiorly with the chevron bones. Loss f articular surfaces in the tail verbrae of mammals allows manyided movements of thet ail. A tail is bsent in apes and man. The whales ave two lobes of tail fin which re at right and left. In different nammals it is differently modified. is bare with the heavy species like oars; small with the shaggy ones s in bears; very long and bristly s in horses. Oxen's tail has a very ong stem, with a tuft at the end, nd in asses it is longer than in

horses, but it is bristly in beasts of burden. A lion's tail is shaggy (woolly, covered with rough hair) at the end, as with oxen and shrew-mice, but not so with leopards. Foxes and wolves have a heavy tail as have sheep. Pigs curl the tail, dogs of low breeds keep it between their legs, otherwise upturned.

Hence, during tetrapod evolution, tails of various animals became adapted in diverse ways, e.g., (1) tail acts as a powerful organ for locomotion in lishes, tailed amphibians, crocodilians, beavers and whales, (2) as a prehensile organ in the American monkeys, Oriental langurs, chamaeleons and sea-horses, (3) for self-defence as in lizards and geckos, (4) as a balancing organ in animals that walk or leap mainly on the hind legs such as kangaroos and squirrels. During winter season when squirrels hibernate, the hairy tail acts as a blanket, (5) it acts as a covering the anus and genitalia, (6) for storing food (fats) in Heloderma, the poisonous lizard, (7) as a

fly-whisk in cattle and hore (8) as a seat in kangaroos, (9) carrying the young ones as in so shrews and opposums, (10) providing a sensitive under-surf in monkeys, (11) as a signal warning of danger in rabbits, where such times, (12) for steering flight in birds, and (13) for sex display in birds of paradise a peacocks.

Further reading

- Norman, J.R. (1963) A Hist of fishes, Ernest Benn Limit London.
- Ayyar M. (1958), Ekambranat Zoology of Mammal Part
 S. Viswanathan, Madras.
- Webster, D. & Webster, M. (19)
 Comparative vertebrate morp
 logy. Academic Press, New Y
 & London.
- Structural adaptations of ver brate bodies, Scientific America 1968.

OURCE-SINK RELATION (Continued from page 725)

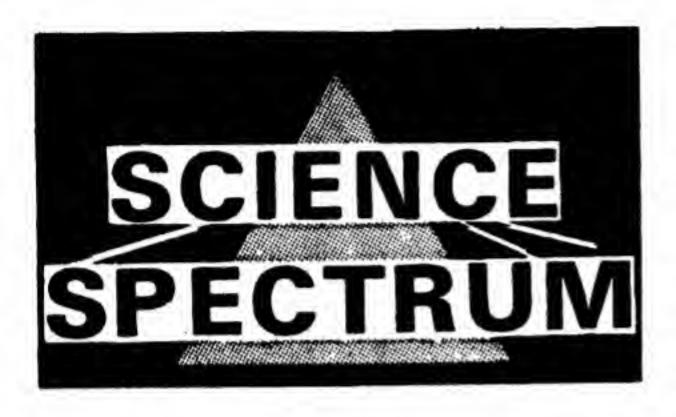
a crop for higher yields in a given rea. Nevertheless, one has to keep mind that mere manipulation of ource or sink is not enough to ring about the desired levels of ield. In such cases agro-climatic ariations of the area deserve equal riority. A deep insight into these spects to identify the problems in idividual cases in a given area ould go a long way in evolving meaningful approach to experiiental manipulations. Nevertheess, any attempt to enhance the ink capacity is definitely a new, ght approach to achieve higher ields. The great task that lies

before plant physiologists is to carefully and critically examine the sink potential of each crop and secondly the means to realise such potential.

Further reading

- Asana, R.D. (1968), Ind. J. Plant Physiology, 11: 1-8.
- Beevers, H. (1969). In: Physiological aspects of crop yield, Editors: Eastin et al.
- Evans, L.T. (1972), Rice Breeding, International Rice Research Institute, Manila, p. 123.
- 4. King, R.W., Wardlaw, I.F.,

- and Evans, L.T. (1967), Pla. 11: 261-276.
- Neales, T.F. and Incoll, L. (1968), Bot. Review, 34: 1 125.
- Nosberger, J. and Humphi E.C. (1965), Ann. Bot., 579-588.
- Sinha, S.K. (1974), Ind. Genetics, 34A: 988-994.
- Stoy, V. (1969), In: Physical Aspects of Crop You Editors: Eastin et al., p.
- Yoshida, S. (1972), Ann. I Plant Physiol.
- Wardlaw, I.F. (1958), Bot. F.
 34, 79-105.



Microwaves in respiration measurements

PTICAL and acoustic radiations have been used for long as luable tools in biology and medine. Microwaves which eir wavelengths in the range of cm to 1 mm have now found eir use in diathermy-a method of edical treatment to heat the body sues by the passage of a high equency electric discharge. For the eatment of animal tumors by emotherapeutic drugs, aves are currently being used to eat the body tissues. Except for athermy, microwave devices are rely seen in clinics. arp contrast to optical and acouscal radiations. The use of miowave instruments in clinic deserves ore attention now because many pects of microwave interaction ith the human body have come to ht.

Recently, Dr. James C. Lin, Wayne State University, U.S.A., ported (*Proceedings of IEEE*, Oct. 75, p. 1530) the use of microaves in respiration measurements.

He claims that his method has several advantages over the conventional techniques because it does not require a direct contact with the subject (human being). With the use of this technique, the problems such as skin irritation, restricted breathing and loose electrode connections are easily eliminated.

The method for measurement o respiration with microwaves is simple It does not require contact with the subject; in fact, the subject may be fully clothed. Microwave radiation from a special type of antenna known as horn antenna is directed towards the upper torso of the sub ject and the reflection from the chest is detected and compared with the transmitted waves. The resultan signal is measured to give respirator information. As a matter of fact upon incidence on the subject, the microwave signal is modulated bot in amplitude and in phase by th moving chest wall. The scattered energy modulated by the respirator measurements is detected by a crys tal detector mounted on the re ceiving microwave horn. Signal i fed to the ratio-meter, a device which is capable of comparing two signals to compute the instantaneous rational between the scattered and the re ference signal. The output of th ratio-meter is the voltage, whos frequency corresponds to th rate of respiration.

In Fig. 1, an experimental set-us for such measurements is shown. This set-up consists of a microway source, an attenuator, a directional coupler, a ratio-meter, an amplified a recorder, a detector, two microscopics.

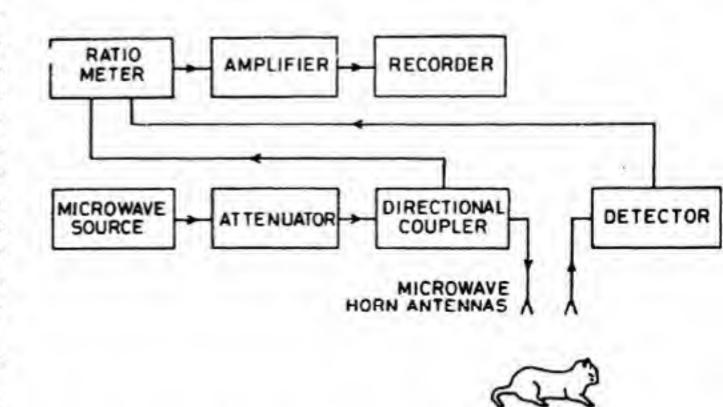


Fig. 1. Experimental set-up of non-contact microwave respiration measurement

I 200 mv

another series of experiments the subject was a seated man breathing deliberately at approximately 47 times a minute. The distance between the subject and the antenna was again 30.4 cm. The typical results of such an experiment are shown in Fig. 3. It can be seen from

these examples that the techniqu is very useful for respiration measure ments.

> VUENDER SHARM Microwave Laborator Deptt. of Physics & Astrophysic, Univ. of Delhi, Delhi-10000

In. .

Fig. 2. Microwave measurement of respiratory movement of intact rabbit Fig. 3. Microwave respiratory measurement for seated human subject breathing at 47 times per minute

wave horn antennas and the subject The microwave (man or animal). source generates microwaves signal at 10 kilo-megacycles per second with a maximum output power of 10 milliwatts. The attenuator which absorbs power is used to control the power of the microwave signal. The directional coupler is capable of dividing power into two arms with definite amounts. One arm of the directional coupler is connected to the microwave horn antenna to transmit the signal while the other arm is joined to the ratio-meter. The second antenna receives the signal reflected from the chest of the subject. The detector detects the received signal and sends it to the ratio-meter. The amplifier is put in the set-up to amplify the output of the ratio-meter and the amplified signal is recorded on the recorder.

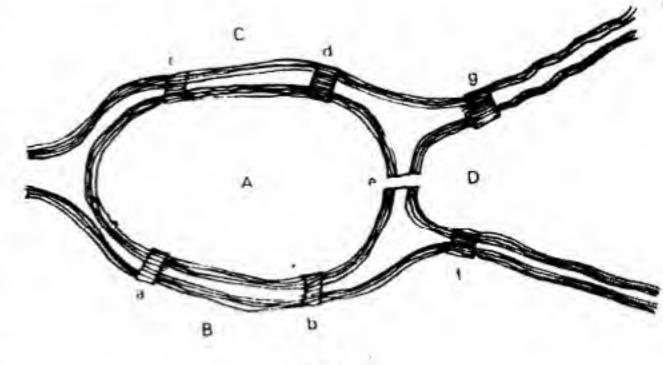
In one series of experiments, Dr. Lin used a 5.1 kg albino rabbit, which was kept at about a distance of 30.4 cm from the antenna. typical recording of respiration of this subject is shown in Fig. 2. In

Seven bridges of Koenigsberg

THERE is a well-known topological problem with the title given above. In the 18th century, there were seven bridges across the river Pregel in the town of Koenigsberg. (the birthplace of eminent philosopher Kant) Prussia. They connected two islands (one of them being Kneiphof) in the river with each other and the opposite banks. Now, the question is whether a person can plan a continuous walk without recrossing any of the seven bridges. In other words, the person has to cross each bridge only once and no more. Leonhard Euler and a number of mathematicians and scientists tried to solve the problem. They followed the trial and error method. They tabulated carefully all the possible paths and then inspected

whether any of these tabulated path satisfies the condition of the problem The method is tedious and difficubecause of the large number of conbinations involved. Moreover, th is not a general method; it canno be applied to problems involving any number of bridges. Euler wa the first to find a general methol which would tell whether such ; journey was possible or not.

Let us designate various lan areas (Fig. 1) that are separated from one another by the river as A, B, and D and the bridges as a, b, c, d, i f, g. Let us also denote the journe from one land area to another, say for example, from A to B (across or b) as AB. The journey AB mear, that a travelier started from A t arrive at B. Now, if the sam



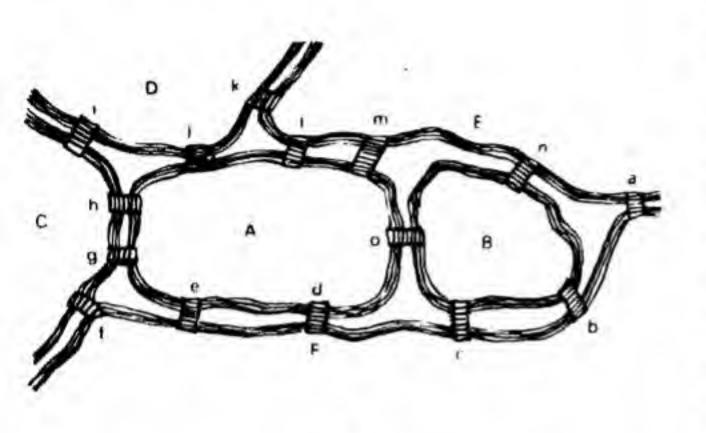


Fig. 2

aveller goes to D across the bridge then the second journey is simply D, and we denote the consecutive urneys as ABD. Similarly, if the ime traveller proceeds to C from across g, we denote the whole urney as ABDC. In this system, e find that when a person is crossing single bridge, the number of letters ecessary to denote his journey is when he crosses two bridges, e number of letters to denote the urney is 3; when he crosses three ridges, the number of letters is 4; id so on. So, a journey is described a number of letters one more than e number of bridge crossings. ere, it does not matter whether a rson goes from A to B by a or b; deals with only wherefrom e starts and where one reacnes. a route can be made in such a way at each of the seven bridges of penigsberg is crossed once only, en we shall require eight letters to scribe that route. Further, in the ter series the combination AB BA) will have to occur twice as ere are two bridges, viz. a and b, ning A and B. Similarly, AC will cur twice but AD, BD and CD Il occur only once.

Let us formulate another rule. Consider a particular region, say A, to which one or more bridges lead. If only one bridge leads from say B to A, then we can designate the route either as AB (when the journey is made from A to B) or as BA in a manner already described. Here the region A is mentioned once only. If there are three bridges leading to A from B then the route will be B -- A through the first bridge, A → B through the second bridge and again B → A through third bridge. The route thus can be described as BABA. It may be the case that all the bridges do not lead from B only, but say two from B and one from another region C. In that case the route will In any be expressed as CABA. case the region A is mentioned twice in the symbolic expression of the journey. The case when there are two bridges joining A and C and one bridge joining A and B gives the same result. Similarly, if there are five bridges leading to A. the symbolic expression for a route that crosses them all only once will contain A three times. A rule can thus be formulated: If the number

of bridges is odd, increase it by or and take the half of the sum. The quotient will give the number of times the region will occur in the symbolic expression of the route.

In case of Koenigsberg problem there are five bridges leading to A three to each of B, C and D. The according to the rule, A will occu three times and each of B, C and will occur twice in the symbol expression of the journey. The sum of the number of times th letters A, B, etc., occur in the symbol lic expression of the journey is According to Euler, if the number of bridges plus one is equal to the sur of the numbers which indicate ho often each individual letter (repri senting a region) must occur, the the journey crossing the bridges one only is possible. In case of Koenig berg bridges problem this sum (viz., is greater than the number of bridge plus one (viz., 7 + 1 = 8). Hence such a route cannot be constructed

The method so far developed not yet complete because in case of Koenigsberg problem all th regions were approached by od numbers of bridges and we did no feel the necessity of considering th case where an even number of bridge approach a region. Let us no suppose a particular region, say A approached by two bridges. There if the journey starts from A, then will occur twice in the denotatio of the route but will occur once onl if the journey starts from som other region. Similarly, if A approached by four bridges, the A will occur thrice if the journe starts from A, and twice if th journey starts from other region Thus, if an even number of bridge leads to a region A, then the number of occurrence of A in the symboli expression of the route is half th number of bridges leading to A i case the journey starts in a regio other than A, but one more if journe starts from A. The general principl to determine whether the route i

Table 1. First problem

Region	No. of bridges leading	No. of occurrence of the region in the expression of the route	
A	5	3	
B	3	2	
C	3	2	
D	3	2	
		Total 9	

The number of bridges plus one =7 + 1 = 8. Therefore such a route cannot be constructed.

Table 2. Second problem

Region	No. of bridges leading	No. of the	of occurrence the region in expression of the route
A .	8		4.
В	4		2
C	4		2
D	3		2
E	5		3
F	6		3
	7	otal	16

The number of bridges plus one =15 + 1 = 16. Therefore such a route can be constructed.

possible or not is: if the sum of the numbers, which indicate how often each individual letter must occur, is equal to the number of bridges plus one, the journey is possible provided it starts from a region approached by an odd number of bridges. But if the sum is one less than the number of bridges plus one, then also the construction of such a route is possible if the route starts from a region approached by an even number of bridges. For example, consider another problem where six regions are connected by 15 bridges as in Fig. 2.

Here, if we designate the regions by A, B, C, D, E and F and the bridges by a, b, c,....n, o as in case of Koenigsberg problem, then the number of bridges plus one is 16 and the sum of the number of occurrence of regions is 4 + 2 + 2 +2 + 3 + 3 = 16. Hence such a route is possible if it starts at D or E. Euler gave the expression of the

route as:

EaFbBcFdAeFfCgAhCiDjAlEmAo BnEkD.

After thorough observation of the problem the following rules are formulated to complete the method.

(a) If there are more than two regions which are approached by an odd number of bridges, no route satisfying the required condition can be found.

(b) If, however, there are only two regions with an odd number of approach bridges, the required journey can be completed provided originates in one of those regions.

(c)-If, finally, there is no region with an odd number of approach bridges the required journey can be effected, no matter where it begins. The problems considered in this article can be tabulated as in Tables I and 2.

> S. KARANJAI Deptt. of Maths P.O. Univ. of N. Bengal W.B. 734430 M. SEN Siliguri College P. O. Siliguri W.B. 734401

The versatile silicones

CILICONES have made news in but when it combines with carbon class. They contain carbon, hydrogen, silicon and oxygen. Silicones are a group of semi-inorganic polymers of alternate silicon and oxygen atoms with various organic groups attached to silicon atom. One of the commonest monomers is dimethyl silicone, (CH₂)₂SiO, which gives a polymer having a repeating structure -Si(CH₁)₁-O-Si(CH₁)₂-O-

Silicon is a tough and stable element

O recent years as a new family of it forms a durable, soft and glass-like synthetic resins of silico-organic material which goes under the name of silicones. They may be obtained in many physical forms such as a gas, as a mobile liquid, as a thick oil, as a rubber-like elastic material as an adhesive, and even as a hard substance like stone. In many industries and appliances, silicones find wide use in making waterproof clothes and papers, waterproof rain-coats, waterproof grocery bags shoes and dresses impervious to rain or water. Silicones are used as lubricants in high-flying aeroplanes as they do not freeze even at -40°C and never vapourize even at as high a temperature as 200°C. Silicone paints and varnishes can withstand high temperatures, dense sunlight and corrosive chemicals without the slightest sign of deterioration. To sum up, silicone products are used in a host of materials from television sets and hypodermic needles to baby bottles. According to an estimation by an American company, silicone materials are now in use in almost all basic manufacturing and processing industries.

Medical use of silicones is far more amazing than its other uses. Its recent use in plastic surgery has brought about a revolution in the medical world. Repair of ears, jaws, noses, breasts and other parts of the body has brought mental as well as physical relief to hundreds of men and women. Its recent use to build up the ugly chin of a lady secretary in Portland, Maine, who was much depressed for her ugly appearance, is a marvellous achievement of plastic surgery with silicones. A Philadelphia woman who had a saddle nose got it operated and rebuilt with silicones and looked prettier. A Chicago girl lost one of her ears in a dangerous car accident. She got it replaced in natural look with silicone implant.

Denis Lee, the Associate Professor of Art in the University of Michigan, U.S.A. and Director of Medical Illustration at the University's Medical Center, has perfected a method to restore life-like ears, noses, fingers and disfigured faces with materials made from silicone rubber. He was able to restore lost parts with

all realism including flesh tones in hundreds of men and women who suffered these losses due to various accidents. Persons suffering from arthritis in hands and legs are being helped with silicone implants of finger joints. These finger joints are able to restore function of hands crippled by rheumatoid arthritis. Numerous replacements like wrists, jaws, elbows, knees and toes are being done with the help of silicone materials.

The family of silicone materials was first explored by an English chemist, F.S. Kipping, Professor in Nottingham University, England in the early part of the present century. He was more interested in its chemical structure rather than its versatile application. In 1943, an American company became interested to produce silicones not only for their military use in insulation and as grease for military aircrafts, but for medical use. They became the sole producers of various silicone products suitable for medical use and established centres for aid to medical research in Midland, Michigan for carrying out investigations in medical silicones. They are now the largest supplier of implantable soft tissue substitutes in the world.

The first noteworthy success of silicones was when glass was coated with silicone. The liquids did not adhere to it. This meant that the injection bottles will be completely drained off when they are coated inside with silicones. Blood would not clot ordinarily if kept in a silicone-coated glass bottle. This resulted in a complete revolution in the storage of blood in blood banks. Silicone rubber tubing developed in 1955 had a wonderful application

inside human body. There is a peculiar disease named hydrocephalus or 'water on the brain'. Here the spinal fluid accumulates in the brain resulting in an abnormal enlargement of the brain. The most successful treatment of the disease is to drain off excess fluid from the brain through a silicone tubing to other parts of the body, especially the abdominal cavity. As many as 300,000 lives have been saved so far by this technique.

Silicone materials have amazing permanence showing little chemical change. They are the only tissue substitute the body never rejects and which remain permanently soft like Silicone rubber natural tissues. tubings may be implanted inside the body to replace urethra—the duct through which our body discharges urine. Silicone tubings are being planned to be used as a substitute for bile-ducts, tear-ducts, tracheas and ureters. Some silicone materials are also being planned to reinforce hernias and to aid in the replacement of tendons in the heavily scarred tissues.

Hypodermic needles coated with silicones are less painful than non-treated needles. Silicones are in use in heart pacemakers and in repairing detached retinas of the eye Silicone capsules for medicine are being planned which will release minute amounts of drugs after a long period of time. Silicone fluid injection is helpful in removing facial contours due to age and to iron out wrinkles of the face.

GOKULANANDA MAHAPATRA Chemistry Deptt Ravenshaw College Cuttack

SCIENCE SPECTRUM

Aeroponics

THE artificial culture of plants in a medium other than soil has been known for years and has enabled plant physiologists to trace the role played by different mineral elements in the growth of plants. The usual techniques include hydroponics, tank farming, tray agriculture, nutriculture, etc. in their latest paper in Plant Physiology (1976), 57, 344-346, John S. Torrey and his colleagues at Cabot Foundation, Harvard University (U.S.A.) describe a novel 'Aeroponics' technique where plants can be grown with their roots constantly bathed in a mist of nutrient solution.

The aeroponics system consists of a polyethylene-lined plywood box. the top of which has a strong, rigid, moulded and compartmentalised plastic fluorescent screen called 'egg crating'. The plastic screen is further covered with polyethylene and heavy duty aluminium foil. Holes which hold the plants with their root system hanging inside the box are made in the plastic foil using a razor blade. An impellor system composed of a motor attached to a board above the box, a stainless steel shaft connecting the motor and the spinner, and a spinner having small openings at the top and its tip dipped in the nutrient solution in the box is used to propel nutrient spray into the chamber. When the the motor is on, the nutrient solution is sucked in by the spinner through centrifugal force and is atomized through the small openings above, thus creating a highly nutrient, rich, misty environment from which the plants can well take nutrients and grow. The assembly of the system is outlined in Fig. 1

The advantages of such a system

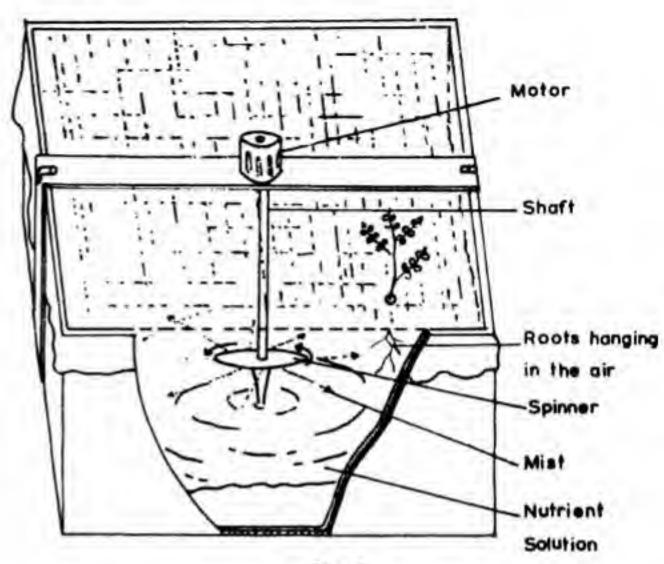


Fig. 1

are many. It is a simple inexpensive technique without involving complex machinery and is easy to operate. Plants grow luxuriously in aeroponics primarily due to the ion-rich aerobic environment. Unlike water culture experiments (hydroponics), aeroponics favours a good root hair formation which is an important consideration for studies on nodulation in legumes. A uniform infection of the roots with rhizobium can be easily achieved by simply introducing the bacterial suspension

into the nutrient pool. Above all, it is possible to get clean and intact samples of root without any mechanical injury for chemical or histological analysis. Apart from legumes, other herbaceous and woody species have also been successfully grown aeroponically at Cabot Foundation Laboratories.

Deptt. of Biological Sciences

Madurai University

Madurai 625021

Morphactins: a novel group of synthetic plant growth regulators

IT is now well established that plant growth is regulated in its natural course by a set of different hormonal substances in complex interactions among themselves and other non-hormonal factors. Since the discovery of the first naturally

by the Dutch scientist W.F. Went in 1926, extensive researches have revealed the existence of such diverse growth hormones as gibberellins, cytokinins, abscissic acid and ethylene in plants. In addition

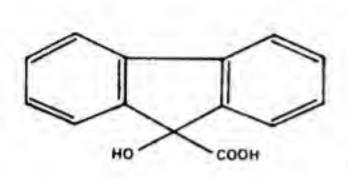


Fig. 1. 9-hydroxyfluorene-9-carboxylic acid

to these naturally occurring hormones, a number of synthetic growth regulators are known to affect plant growth appreciably in a variety of ways. Among the synthetic growth regulators, morphactins, developed in the famous research laboratory of E. Merck, Darmstadt, Germany, raised considerable scientific and practical interest since its discovery in the early part of the last decade.

Morphactins are highly active in plant morphogenesis. While at low concentrations they induce such diverse modifications of growth as stimulation of axillary branching, modification of sex, development of parthenocarpic fruits etc. concentrations mostly result in dwarfism. It is interesting to note that most plant species can tolerate a high amount of morphactins without any noticeable phytotoxic or herbicidal effect. This is because morphactins are rapidly metabolised in plants. An application of low to medium concentration of morphactins makes plant recover fast and return to normal growth. It is also possible to achieve some sort of storage supply by treating the plant with high concentrations of these nontoxic growth regulators and thereby prolonging their effects.

So far it has been found that morphactins are nontoxic to several species of animals also. Moreover, they do not persist long after application into soil or water due to rapid attack from microbes, thus having no residual problem. This is in contrast to the majority of known synthetic growth regulators such as TIBA (triiodobenzoic acid), B-995 (N-dimethyl aminosuccinamic acid), Amo-1618 [Ammonium (5-hydroxy-carvacryl) trimethyl chloride piperidine carboxylate], MH (maleic hydrazide), CCC [(2-chloroethyl) trimethyl ammonium chloride], etc. Besides breakdown by microbes, morphactins are also destroyed by UV light and high temperature.

Chemical structure

The basic structure of a morphactin is a fluorene skeleton bearing a carboxylic acid group in the 9-position (Fig. 1). A hydroxy group in position 9 causes marked increase in its effectiveness. The resulting 9hydroxyfluorene 9-carboxylic acid is known as flurenol common name ISO or flurecol (BSI)]. A further increase in its activity is achieved by halogen substitution at the 2position of the fluorene skeleton, especially with chlorine (Fig.2), the resulting substance being known as chlorflurenol (ISO) or chlorflurecol (BSI). In addition to the free acids, their esters and salts are also effective. The methyl ester of chlorflurenol (code name: EMD IT 3456) is the most active morphactin derivative tested so far and therefore is most commonly used.

Biological activity

Absorption, transportation and accumulation. Although morphactins may be absorbed by germinating seeds and the roots, the leaves are the most efficient organ for absorption. Within the plant, morphactins are transported and distributed in a non-polar manner in contrast to auxins but similar to gibberellins. In young vegetatively growing plants, the transport is predominantly acropetal, i.e., from morphological base to the morphological apex, but in

mature plants basipetal move ment also occurs. Morphactins are mostly accumulated in growing buds and in meristems which seem to be the primary sites of morphactin action. Hence, it is only the new growth which is affected while matur organs remain more or less un affected.

Germination and sprouting. More phactins inhibit or rather delay germination of seeds, most likely by interfering with the activity of various mobilizing enzymes. Likewise sprouting of potato, beet and onion can be substantially delayed by spraying plants several weeks before harvest.

Stem elongation and leaf growth Morphactins when applied in sufficiently high doses result in stunted growth of shoots, mainly due to inhibition of the extension growth of newly growing internodes. Reduction in the number of newly formed internodes has also been recorded.

Leaves which appear after appli cation of morphactins are usually smaller in size, thicker in texture and darker in colour. Often extreme leaf deformation occurs. Compound leaves are sometimes changed to simpler form. The ability of morphactins to retard breakdown of chlorophyll and to prolong longevity of leaves may be interpreted as a delay in senescence, which was so long known as a typical cytokinin Marked decrease in transpiration and need for water supply following morphactin treatment indicates its possible role in the improve ment of drought resistance.

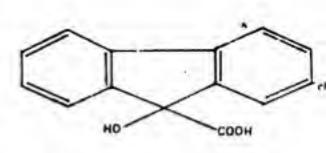


Fig. 2. 2-chloro-9-hydroxyfluorene-9carboxylic acid

Apical dominance and branching. Application of morphactins considerably weakens or completely removes the apical dominance of shoots. This results in increased branching producing a dwarf, compact and bushy plant. Such effects, however, vary considerably depending on the species and the concentration of the chemical. In graminaceous species (such as rice, wheat) profound increase in tillering has been recorded with morphactins if applied at pre-tillering stage.

Root growth and root branching. Contrary to the shoots, the extension growth of primary or tap roots is often stimulated by morphactins whereas laterals are strongly suppressed. This type of selective inhibition is typical for morphactins and can well be utilized as a method for its bioassay. Another interesting feature of morphactin effect is increase in the size of root hairs on both main and lateral roots. An increase in the density of root hairs and in the length of the root hair zone has also been reported, which accounts for an increase in the absorbing surface of the root system.

It has been further observed that morphactins in very lew concentration disturb the normal gravity directional growth of roots, causing them to grow ageotropically in any direction, even out of the soil.

This effect, which has great practical implications, was shown in various woody and herbaccous crops like different varieties of pome and stone fruits, soybean and other legumes. tomato and cucumber. the total number of flower buds is affected, but also their position on the shoot. For example, in peach more flower buds appear in the basal region of the bearing branches. This makes possible to maintain sufficient potential fruiting area even with heavy pruning which is the common practice in peach growing.

Morphactins have diverse effects on sex expression of flowers. In bisexual flowers (e.g., tobacco) they suppress male sex. In monoecious plants, that flower sex is favoured which is normally suppressed in the early ontogenesis. For example, female in cucumber and male in ridge gourd. In dioecious species it induces both the sexes.

increases the number of flower buds.

Not only

Similar to other growth substances like auxins and gibberellins, morphactins tend to induce parthenocarpic (seedless) fruit development. Application of morphactins in low concentrations during flowering leads to the development of seedless fruits in cucumber, tomato, cherry and

Fruit drop usually occurs if morphactins are sprayed soon after flowering. This effect may be profitably utilized for thinning of fruits in apple, peach, grapes, etc. Moreover, loosening of mature fruits has also been reported when morphactins are applied some time prior to harvest. This may be helpful in the mechanical harvesting of fruits.

Increase in yield

Morphactins are said to increase plant products of economic importance such as sugars, latex, oils, alkaloids and steroids In Hevea. latex flow is stimulated to give an yield increase of about 20%-25% following application of morphactins. Morphactins are, therefore, a novel group of synthetic growth regulators profoundly affecting various physiological and morphogenetic processes. Subject to further experimental verifications, the practical applications of morphactins in agriculture seem to be many and diverse.

> M.K. SADHU College of Agriculture Calcutta University Calcutta

Flowering and fruiting

Morphactins may increase or decrease the number of flowers depending upon the concentration and time of application. High concentration of morphactins applied towards the end of flower bud differentiation causes partial or complete prevention of flowering and the plant remains vegetative. On the other hand, low concentration appplied shortly prior to or at the beginning of normal flower bud differentiation

Ageing in poikilotherms

TN contrast to homeotherms, birds A and mammals, which can maintain a constant body temperature independant of the environment, all other animals are termed poikilotherms (from Greek, poikilos, meaning variegated). This means that they lack the effective internal mechanism for maintaining a constant temperature and that they depend on the

environment. By adjusting only to the amount of heat available they can, to some extent, control their own temperature.

It may seem somewhat surprising that some of these 'cold and doubtfu beings' are among the longest live in the animal kingdom. While man the longest lived among the homeo therms, has a life span of approxi mately 120 years, some of the fishes like carps and pikes are believed to be capable of living up to 170, 200, 300 or even 400 years (Comfort, 1964). The tortoises are likewise Testudo sumeiri, the Morifamous. son's tortoise, has a recorded longevity of 152 years, and Testudo elephantopus of the Galapagos islands 100 years or more. Among the invertebrates, although few accurate data are available, the giant clam, Triadaina gigas, the largest of which may weigh almost 600 lbs is estimated to live upto 100 years.

The longevity of the poikilotherms may be due to their pattern of growth. There is an interesting difference in the pattern of growth between poikilotherms and homeotherms. growth in poikilotherms is indeterminate while that of the homeotherms is determinate. Poikilotherms continue to grow even after sexual maturity as long as sufficient food is available. They are able to fight off the extrinsic causes such as parasitic infections, diseases, predators etc., and in none of them the reproductive capacity declines with age and size (Persp. Biol. and Med., Vol. 17, No. 4, 1974). Their vital organs such as the brain, heart muscles and kidneys probably continue to produce new cells throughout life so as to keep pace with the over all body growth. Also, their secondary centres of ossification in long bones, epiphyses, probably never unite with the shaft thus making continuous growth of the bones possible. In homeotherms, birds and mammals, there is very little body growth after sexual maturity as the epiphyses get fused with the main shaft of the long bones, diaphyses, ruling out any further increase in length. The vital organs such as, brain, heart and lungs lose their power of growth even much earlier. For example, in man, there is no increase in the number of neurons after six months of infancy. Further increase in brain growth is due only to hypertrophy of the individual nerurons and increase in non-nervous glia cells. The same is true of the heart, muscles and kidneys. So, the birds and mammals cannot grow further than what their vital organs will permit.

Not only the ability to produce new cells in the vital organs is limited in homeotherms, there also is progressive loss of these cells after maturity. The number of neurons in the mouse barin, for example, decreases from about 5.5 million at birth to about 2 million in old age, and the nephron population in the kidneys falls to one half the number present in young and adult stages. Since the cell loss in

vital organs of homeotherms is irreparable, one wonders if such losses are the cause of senescence.

In conclusion, therefore, the question may perhaps be asked: If some animals can continue to grow throughout life, why do we, the homeotherms, stop growing at a predetermined stage, and start ageing Unfortunately very little work has been done on the poikilotherms to explore the precise nature of the mechanisms involved.

Suresh Chandra Padh Zoology Deptt. Berhampur University Berhampur (Orissa)

Vitamin C

THERE is hardly any field related to health and disesase which does not refer to the beneficial effects of vitamin C (anti-scorbutic vitamin, ascorbic acid).

Aging

Man has to depend on exogenous supply of vitamin C which is required for the formation and integrity of a major structural protein, collagen, present in skin, bone, cartilage and tendon. Intake of vitamin C in sufficient amounts is essential for the general stimulation of various vitamin C-dependent enzymes. In old age, the deficiency of vitamin C is frequently observed, which is probably due to altered metabolic processes in old age. If, however, adequate amounts of vitamin C are taken from the beginning, the onset of lesions of the connective tissue associated with the deficiency of this vitamin can be delayed and the aging process slowed considerably. One can lool young inspite of age.

Atherosclerosis

A deficiency of vitamin C is asso ciated with abnormal cholestero metabolism both in animals and Chronic vitamin C deficien diet increases cholesterol and lipid in blood (Lancet, July 21, 1973) Supplementary vitamin C given to normal individuals tends to de crease serum cholesterol levels. Rus sian cardiologist, A.L. Maisnikov of the Institute of Experimenta Therapeutics, Moscow said in 196 that long term supplementation of vitamin C is therapeutically success ful for the prevention of ischaems heart disease in man. It also prevent the formation of atherosclerosi produced experimentally in an mals (Sokoloff, B., Hori, M., Saelhol C.C., Mc Connell, B. and Imai, T J. Nutrition, 91, 107, 1067). It suggested that as vitamin C is essen substance and collagen formation, the local ground lesions which develop in vitamin C deficiency form sites for deposits of complex carbohydrates, lipids (chiefly cholesterol), blood, blood products and calcium salts (thrombotic deposits) in the walls of the arteries leading to atherosclerosis.

Coronary thrombosis

Some individuals can be considered to be prone to heart attack as result of clot (thrombus) formation n the coronary artery which supplies pure blood to the heart tissue. These individuals can be identified by the study of levels of their serum ipids (cholesterol and triglycerides). If the serum lipids increase, the individual is prone to coronary thrombosis. In such persons the level of vitamin C in serum is found to be low. Vitamin C intake may help them prevent vascular thrombosis.

Deep vein thrombosis

Vitamin C is associated with the health of the capillaries. As in the case of capillaries, vitamin C appears to be responsible for the health of the arteries and the veins as well. In a study conducted in Pinderfields General Hospital, Yorkshire in 1973, patients (vulnerable to deep vein thrombosis) who received vitamin C at the rate of 1 gm/day had less thrombus formation in comparision to those given no vitamin because, in the former, alterations in the blood vessel wall for deep vein thrombosis were minimized by vitamin C. This vitamin provides the ground substance for the blood vessel wall. In the Regional Burns Unit of the same Hospital, since it was opened more than 7 years ago, I gm of vitamin C is being given daily to all patients as a routine treatment

(Lancet, 2, 199, 1973), and no case of clinical deep vein thrombosis has occurred in the last 5 years.

Cancer

It has been suggested that vitamin C might reduce the occurrence of certain types of cancer by blocking the formation of nitrosamines, the chemicals implicated in the aetiology of certain types of cancer in man (Science, 177, 65, 1973). Nitrosamines can be formed in our stomach from sodium nitrite used in meat processing, acid of the stomach and by naturally occurring amines in the body or in the diet (J. Kamm, New Jersey, U.S.A., 1973). About 20 mg per day of vitamin C can be effective in preventing nitrosamine production in man.

Diabetes mellitus

F. Dice of Stanford University's Pharmacology Department, U.S.A. showed in 1972-1973 that by taking increased doses of vitamin C the amount of insulin required for controlling diabetes mellitus could be reduced. Dice, himself a patient of diabetes, had to take initially 32 units of insulin. He decreasthe quantity of insulin, ed taking vitamin C instead. He was able to reduce his insulin needs to 13 units daily by taking in addition II grams of vitamin C per It appears that vitamin C can partially replace insulin needed in controlling diabetes.

Skin disorders

Royal Army Medical Corps of Australia has reported that a liberal dose of vitamin C can keep a man free from prickly heat which is the forerunner of most skin disorders such as ring worm, impetigo and athletes foot. Prickly heat is associated with itching red cruptions on the skin.

Infections and fever

Increased losses of vitamin C accompany infection and fever. These
losses are particularly notable when
bacterial toxins are present. The
adrenal cortex which contains a
large quantity of vitamin C is rapidly
depleted. This suggests that vitamin
C may play an important role in
the reaction of body to stress.

Anemias

Vitamin C is associated with the prevention and therapy of certain types of anemias. Scurvy itself is often associated with anemia which responds to vitamin C. Megaloblastic anemia of infancy, quite common in our country, appears to be associated with vitamin C deficiency. In this type of anemia there is a decrease in the usual red blood corpuscles called crythrocytes while another type of cells called megaloblasts, which are relatively bigger, are found in the bone marrow. In normal individuals it is the megaloblasts that mature into erythrocytes, for which vitamin B, and folic acid are required. This disease responds to the treatment with vitamin C and folic acid. The function of folic acid in correction of anemia is improved by vitamin C. Vitamin C increases both iron utilization and absorption and, as such, is of help in curing iron-deficiency anemia.

Common cold

Linus Pauling of Stanford University, U.S.A., claimed in 1970 that massive doses of vitamin C (2-4 gm/day) prevent or contain common cold, but this has been contradicted by some scientists including those of Common Cold Research Centre at Salisbury. Drs. C. W. M. Wilson and H.S. Loh of the University of Dublin, Ireland, in 1973 reported 2 gm/day of vitamin C

as effective against common cold. Here its action is on leucocytes or tissues rather than on the viruses.

Resistance to temperature

Vitamin C has an important role in adaptation to temperature changes. It helps increase the resistance to high temperature. In an experimental study on frost bite in animals, the severity of frost bite was less in a group of animals which received vitamin C and rutin (a bioflavonoid). This suggests a beneficial role of vitamin C in overcoming frost bite.

Brain amino acids and proteins

In vitamin C deficiency, there is a marked elevation of tyrosine and a decrease of histidine, arginine and amino butyric acid in brain. Synthesis of proteins has also been shown to be decreased in brain of vitamin C-deficient animals. Decrease of \gamma-amino butyric acid is fraught with impaired neuronal function and it is reported that convulsions induced by certain drugs are due to a decrease of \gamma-amino butyric acid in the brain.

Cigarette smoking

In some age groups, heavy cigarette smokers have a higher serum cholesterol and a lower vitamin C than non-smokers. H. S. Loh of the University of Dublin, Ireland, in 1973 associated the increased risk of atherosclerosis and associated diseases to the low vitamin C concentration due to smoking.

All these effects of vitamin C are in addition to its paramount role in preventing scurvy.

The vitamin C content (mg/100 g) of some of the common dietary substances used in India is as follows:

Onion 11, potato 17, Amaranth ender 99, cabbage 124, coriander 135, drumstick 220, radish 103, Agathi 169, cauliflower 56, tomato ripe 27, amla (Indian goosebery) 700, guava 212, orange 68, lime 60, papaya 57, chillies (dry) 50, and liver-sheep 20.

Considering all the above facts on vitamin C, it looks reasonable that a person with normal metabolism can conveniently go in daily for I to 2 gm of vitamin C to look young, to ward off diseases and to be healthy. If he feels he cannot

afford vitamin C tablets, he can tak plenty of coriander, drumstick an agathi leaves and guava and aml fruits. They contain plenty of thi vitamin.

S. RAMAKRISHNAN

Professor and Head

Department of Bio-chemistry

Jawaharlal Institute of Post Graduat

Medical Education and

Research, Pondicherry

Auxotrophic mutants and their uses

change in the chromosomes or A genes of an organism is called mutation. The organism with such an altered genetic make-up is called a mutant. Mutation may result in a change of morphology, resistance or sensitivity to drugs or chemicals or pathogens, loss of ability or increased ability to synthesize any enzyme, etc. Mutants of microorganisms which are nutritionally deficient, i.e., which cannot synthesize one or more metabolites (amino acids, vitamins, nucleotides, etc.) in contrast to the normal type organism (called the wild type) are termed auxotrophic mutants or auxotrophs. That is, while the wild type organism can grow in a medium containing (i) a carbon source, e.g., sugars, starch etc., (ii) an inorganic nitrogen source, e.g., ammonium chloride, ammonium sulphate, potassium nitrate, etc., and (iii) some inorganic salts like those of magnesium, calcium, manganese, iron, copper etc., an auxotroph derived from the same wild type organism cannot grow in that medium unless supplied with one or more specific growth factors. An auxtrophic mutant requiring the

amino acid valine may be called valin auxotroph (or simply, amino acid auxotroph), the auxotroph requiring nicotinic acid a the vitamin nicotinic acid auxotroph (or vita min auxotroph) and so on. The growth medium of the wild type organism is termed minimal mediun while that of the auxotroph contain ing the required growth factor, factors (in addition to the constituents of the minimal medium) is called complete medium. Auxo trophic mutants can be visually identified by their growth only in the complete medium and failure to grow in the minimal medium.

The cause of nutritional deficiency or auxotrophy is the formation of a block, due to mutation, in the biosynthetic pathway of the metabolite. The block is due to the failure of the organism to synthesize an enzyme operative at a particular step in the biosynthetic pathway, bringing an interruption in the synthteic sequence and consequently failure of the particular metabolise So the auxotrophic formation. mutants of an organism, requiring the same metabolite for growth

may be biochemically different, due to having being blocked at different steps of the pathway. Like other mutants, auxotrophs may spontaneously in nature. But they can also be induced artificially by the use of some physical or chemical agents called the mutagens, e.g., X-ray, ultraviolet light, nitrosoguanidine, nitrous acid, etc. The rate of induced mutation is much higher than that of spontaneous mutation. In isolation of auxotrophic mutants, penicillin enrichment method is generally employed. .This method makes use of the selective action of penicillin which kills only the growing cells and practically has no effect on non-growing ones. Microbial cells after treatment with mutagen are allowed to grow in a minimal medium containing a lethal dose of penicillin. As the wild type cells begin to grow, they are killed by the antibiotic but the cells in which auxotrophy has been induced can escape penicillin action due to their failure to grow in a minimal medium. Auxotrophic mutants can backmutate, i.e., can revert again to the normal type which are then called the prototrophs. This back mutation may occur spontaneously and can also be induced artificially by the use of mutagens. Auxotrophs are of great importance in microbiology.

As indicator organism in bioassay tests

The presence of any particular metabolite in a given sample can be detected by employing an auxotroph requiring that particular metabolite for growth. For example, presence of riboflavin in a sample can be detected by adding the sample in a suitable proportion to a minimal medium, and then allowing a riboflavin auxotroph to grow in this medium. Growth of the auxotroph confirms that the test sample con-

tains riboflavin. In fermentation microbiology this bioassay test is of much importance. Organisms producing a desired metabolite, e.g., an amino acid or vitamin, can be detected by employing this test using the corresponding auxotroph.

In the study of bacterial genetics

Auxotrophs are also used to study the recombination process among bacteria, i.e., transfer of genetic material from one bacterium to another forming a recombinant cell. The negative character of auxotroph, i.e., the deficiency of a nutritional factor is used to test whether the corresponding positive character from a related bacterium is transmitted to the auxotroph making it nutritionally independent. For example, suppose two auxotrophs A and B, the former requiring methionine and thiamine and the latter requiring threonine and biotin (but A synthesizing threonine and biotin and B synthesizing methionine and thiamine normally), are mixed together. And if from the resulting mixture any nutritionally independent type which has no requirement for any of the four growth factors can be isolated, it should be taken as a proof of the transfer of genetic material among the two auxotrophs.

An elucidation of biosynthetic pathways

By isolating many nutritional mutants requiring the same metabolite for growth, it is possible to obtain some auxotrophs which are blocked at different points in the biosynthetic pathway of the parti-

cular metabolite. In many cases auxotrophs accumulate the compound which is the substrate of the blocked reaction. By thorough examination of the auxotrophs and their accumulated compounds it becomes possible to explain the biosynthetic pathway. Let us assume a biosynthetic pathway and auxotrophic mutants, blocked at different steps as in Fig. 1. A is the starting material or substrate, E is the end product metabolite while B, C, D are the intermediate compounds.

The auxotroph 3 can grow only when supplied with the product auxotroph E. 2 can grow supplied with either when or E and auxotroph I can grow if supplied with either C or D or E. These three auxotrophs 1, 2 and 3 can accumulate the compounds B, C and D respectively. By identifying the accumulated compounds and determining the growth response of the auxotrophs to different intermediates, the sequence of the pathway becomes clear. It should be noted that an auxotroph blocked at a step is deficient in the enzyme of that particular step only while other enzymes of the pathway are synthesized normally.

As producer organisms of fermentative products

As mentioned above, many auxotrophs accumulate the immediate precursor of the blocked reaction. This phenomenon can be industrially exploited for large scale production of some metabolites. Again, in a

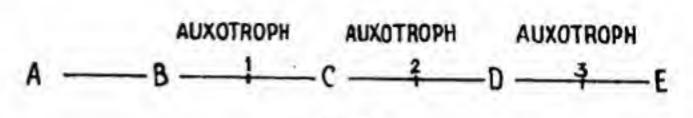


Fig. 1

branched biosynthetic pathway (that is, a pathway in which after first few steps of starting from a substrate an intermediate compound is diverted through different routes resulting in different end products) if any branch is blocked by induction of auxotrophy, the synthesis of end product of the other branch may be increased, provided the nutritional factor required by the auxotroph is supplied to the organism to maintain normal growth. An example may be found in fermentative production of amino acids where high yields of lysine is obtained by using homoserine auxotroph or methionine+ threonine auxotroph. Similarly, threonine can be produced by auxotrophs requiring either lysine, or methionine or both. Moreover, in fermentation microbiology other types of auxotrophs which have no direct relationship with the biosynthetic pathway of the fermentation product are also being employed, for example, in the production of glutamic acid by glycerol auxotroph of Corynebacterium alkanolyticum. Such auxotrophs are said to increase the accumulation of the fermentation product by enhancing the cellular permeability.

SUKUMAR CHATTERJEE
Department of Botany
Burdwan University
P.O. Burdwan (W. Bengal)

inactive the ants are normally During the combat, the ants of alien colonies walk on stilt legs (Fig. 1, above). And when workers or two colonies meet, they confron each other 'head on' (Fig. 1, center). Later, the ants may move sideways and drum intensively the abdomen (posterior end) of each other with their threadlike antennae (Fig. 1, below) situated on their After 10 to .30 seconds, one of the ants usually moves away to restart display behavious with other workers of the alien colony.

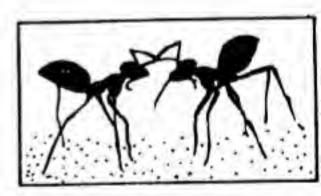
During the tournament, some workers go back to their colonies to recruit fresh workers by repeated jerking movements. At last, the smaller colony, unable to bring fresh recruits to the tournament area, is raided by the larger colony. The

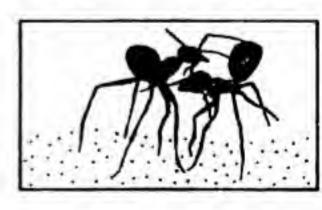
Ants that play fight!

MANY species of ants conduct physical combats with the members of a different colony, even if the latter belong to the same species. In a recent report, Bert Holldobler of the Department of Biology, Harvard University, Cambridge (Science, Vol. 192, 28 May 1976, pp 912-914) has described the fascinating behaviour honey pot ant, Myrmecocystus municus, in some parts of Arizona where foraging grounds of neighbouring colonies overlap. There, massive territorial confrontations are of common occurrence along the challenged territorial borders of nearby colonies of ants. During combat, ants of two colonies follow a gentle, ritualized tournament which sometimes leads to death of a few ants and injury to some members.

How does this tournament begin? When a wandering forager from one

colony encounters some foreign ant(s) of a different colony but of the same species, they start with a display behaviour in which both rise on their stilt legs. After a while, both recede and return to their colonies, dragging their abdomen (body end) over the ground. doing so, these scout ants lay a trail of certain secretion (scent) on the ground. Reaching their nests, scouts perform a rapid jerking movement which alerts the other ants in their respective colonies. And thus a group of 100 to 200 ants sets out for defence of its threatened territory following the same route through which the scout ant had reached Oh reaching the its colony. disputed territory, the ants, summoned from the colonies of both the scouts which had originally met there, start an interesting tournament which may last for several days, interrupted only at nights when





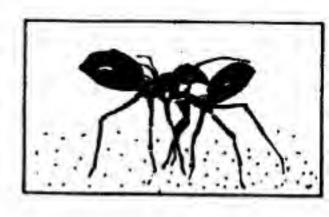


Fig. 1

queen of the former is killed, the eggs and embryos are lifted to the winner colony where they hatch out to work as 'slaves.' M. mimicus, however, does not show this behaviour in the presence of ants of other

species in their region, in the manner the human species fights with members of its own species.

ZAKA IMAM

ZAKA IMAM

Breathing is related to posture

VES, your breathing changes with your body posture. It varies when you sit, stand or sleep and even as you turn in your bed! Have you not at any time noticed that the lower of the two openings of your nose gets blocked when you relax in your bed on one side of your body? If you have not, try it tonight, or if you are so impatient, try it right now. Lie straight down on a bed or a couch on your right or left side and let the right or left side of your head, shoulder and arm bear the weight of the body. Wait for about five minutes, then sit up erect and closing one side of the nose with a finger try to blow gently through the other. You will immediately notice that the side of the nose to which you were lying is partially or completely closed and that little air passes through it.

What is the cause of one sided nasal blocking in the lateral recumbent postures? What is its mechanism and purpose in the body? These questions are interesting because they are related to regulation of respiration—the important most function of the body. A clear understanding of this bodily phenomenon may help solve the problem of blocked noses during an attack of common cold. It may also throw light on why only one side of nose at a time is used in certain yogatype-breathing exercises.

Experiments were conducted on 10 young volunteers to determine precisely the extent of blocking produced in the nasal passages with change of body position. The volunteers were asked to breathe in through the mouth and exhale out through the mose. The air so expired was collected through two tubes separately from the right and the left nostrils into two separate water filled recording spirometers (instruments for measuring the volume of respiratory airs). Care was taken to

see that there was no leak and that the tubes did not obstruct the flow of air. The amount of air so collected was corrected to standard temperature and pressure.

Blocking of the nasal passage is caused by swelling of its inner lining due to accumulation of blood. The nasal airflow, therefore, is proportionately altered and can be used indirectly to measure the extent of nasal engorgement and blocking. arrangement The of apparatus around a volunteer in the sitting position, is shown in Fig. 1. The results of experiments on five commonly adopted body postures are given in Table 1, and are graphically depicte in Fig.2.

The results show that the total amount of air breathed goes on decreasing as the body position changes from the standing through sitting to the horizontal lying posture. This is so because the respective postures are comparatively less exerting and therefore demand progressively less amount of oxygen for maintaining the body metabolism. It is also observed that, though



Fig. 1. Arrangement of apparatus around a subject in the sitting position

Table 1. Shows the effect of five commonly adopted postures on the total amount of air breathed and on the volume of air blown through the right and left side of nose. The values are litres per minute.

Body posture	Total air breathed	Right nostril	Left nostril	Ratio of right:	P. value
Standing erect	13.8	6.2 <u>+</u> 2.6	7.6 <u>+</u> 3.6	46 : 54	>0.10
Sitting in chair	12.6	6.4 ± 1.5	6.2 ± 2.3	51 : 49	>0.40
Lying supine	9.4	5.2 ± 2.0	4.2 ± 1.6	55 : 45	>0.10
Lying on right side	9.2	2.6 + 2.0	6.6 ± 3.4	22 : 78 •	< 0.005
Lying on left side	9.1	6.0 ± 2.6	3.1 + 21	66 : 34	< 0.0125

Each value is a mean of ten observations, I each subject. ± standard deviation. P Significance level for the means of air blown through the right and left nostril using students t test.

the total volume of air breathed varies, there is no change in its nasal partitioning. In the right and left lying positions, however, the relative volume of air streams blown through the right and the left sides of nose differ singnificantly. While lying on the right side in the horizontal position, 2.6 ± 3.4 litres is blown through the left in a The reverse was the minute. case while lying on the left side, 3.1 ± 2.1 litres and 6.0 ± 2.6 litres of airflow was recorded respectively through the left and the right nostrils.

The closing of the dependent side of the nose was always accompanied by a certain amount of opening of the upper nasal air passage. In the present experiments the amount of air exhaled through the upper nostril was 77.8 per cent and 66.0 per cent of the total air breathed, respectively, in the right and the left horizontal side postures. These observations point to swelling and thickening of the inner layer of the dependent nasal air passage and shrinking and contraction in the upper.

In nature, there is always a purpose for a phenomenon. What is the purpose then in causing a block and arresting respiration through the down side of nose, while lying in the horizontal posture? It seems to be a protective function for the where the body lies on the floor or a side, as while sleeping or when

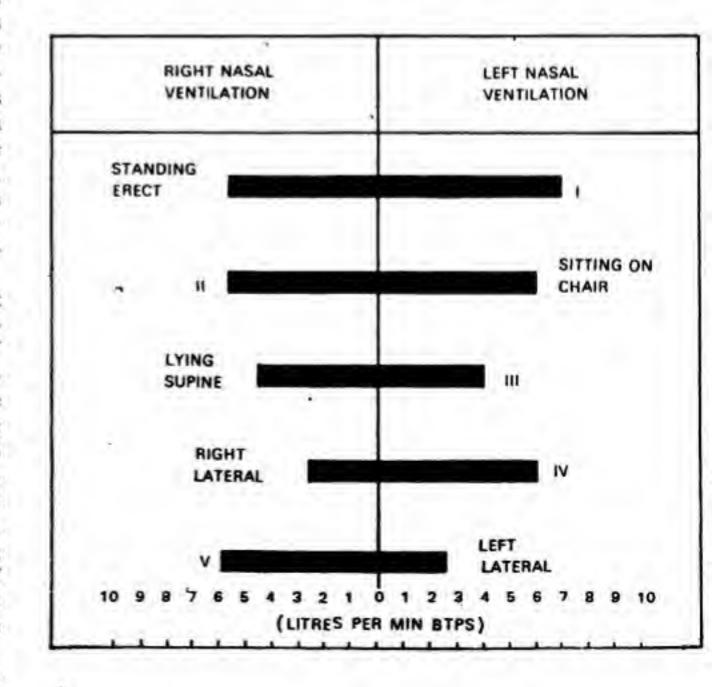


Fig. 2. Depicting the effect of five commonly adopted body postures on air blown through the right and left side of nose

felled unconscious due to some cause, the shutting off the nostril in contact with the floor and opening of the other a little above the floor level, prevents direct sucking of dust and foreign particulate matter from the ground surface. It thus protects the respiratory tract from choking and infection and helps in maintaining the vital function. The advantages of this

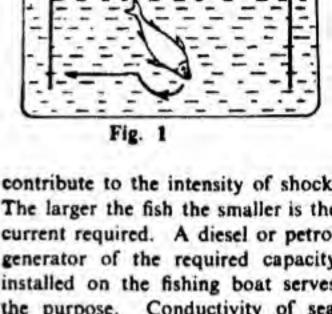
effect to the body are still better appreciated when living conditions of the primitive man in dusty dens are visualised. Protective reactions in mucous membranes (inner linings) in other parts of the body are also known to occur in man during periods of stress and emotional conflict.

SHANKAR RAO ANIL KUMAR POTDAR

motional KAR RAO COI

600

measures.



SCIENCE SPECTRUM

The larger the fish the smaller is the current required. A diesel or petro generator of the required capacity installed on the fishing boat serves the purpose. Conductivity of sea water is 500 times that of fresh water because of the presence of salt Hence, a voltage 500 times of that required in fresh water is necessary to produce similar results in sea water. Operations of such high voltages on-board fishing vessels may at times, prove dangerous to the operators unless they are well trained and observe strict precautionary

Impulse currents are more suitable in sea water. The idea here is to send strong electric impulses or intermittent currents between two electrodes implanted at two convenient points in the sea water. A battery of accumulators or a d.c. generator is used as the source of current. A series of condensers, connected parallel to each other, are charged with this current. The condensers are then allowed to discharge in series. Impulse current has got a much greater neuro-physiological activity than direct or alternating current.

Electrical fishing can claim serveral advantages over conventional methods. Selective fishing is possible in both fresh and sea water as the threshold voltages required for narcotising fishes are specific to species and size. Areas like narrow crevices and those with rocky and uneven bottoms can be successfully fished with this gear. Conventional gears cannot operate satisfactorily in such places. It is well-known that fish

Fishing with electricity

THE varied uses of electricity in every day life are well-known to every day life are well-known to us. As many of us may be aware, electricity is produced when a coil of wire is rotated between the opposite poles of a powerful horse-shoe magnet. This was demonstrated by the British Scientist, Michael Faraday, in 1831 to the then Chancellor of Exchequer, Mr. Gladstone. latter then asked, "Of what earthly use is it to humanity?" The former lost no time in retorting, "Sir, you can tax it". Today electricity earns enormous amounts of taxes for the governments, besides serving humanity in innumerable ways. One of the latest applications of electricity is in fishing.

The principle involved in this type of fishing is to stun the fishes with an electric shock of the required intensity. The stunned fishes float motionless on the surface of water and then they can easily be collected by means of hand scoop nets. There are some fishes like electric ray and torpedo which produce strong electric impulses for driving away their enemies. Perhaps man borrowed the idea of fishing with electricity from these animals.

The first interesting discovery in this connection was made by some German scientists who observed that

when a direct electric current is passed through water containing microscopic aquatic organisms called 'planktons," they are collected around the anode. This sort of attraction occurs in the case of fishes also (Fig. 1). The current produces a potential difference between head and tail of the fish. This is called 'body voltage'. If the voltage is slightly increased, the fish starts swimming towards the positive electrode. This phenomenon is called 'electrotaxis' or 'galvanotaxis'. In case the current happens to be strong enough, another reaction called 'electronarcosis' or 'galvano-narcosis' takes place by which the fish gets stupefied, stunned or narcotised and floats on its side, incapable of any voluntary move-If the current is now disconnected, the fish slowly regains consciousness and mobility and swims away. The time interval between withdrawal of the current and regaining of mobility by the fish is called the 'recovery time', which is directly proportional to the intensity of shock. That is to say, the greater the shock the longer is the recovery time.

In practical application, many factors like voltage employed, size of fish and conductivity of water

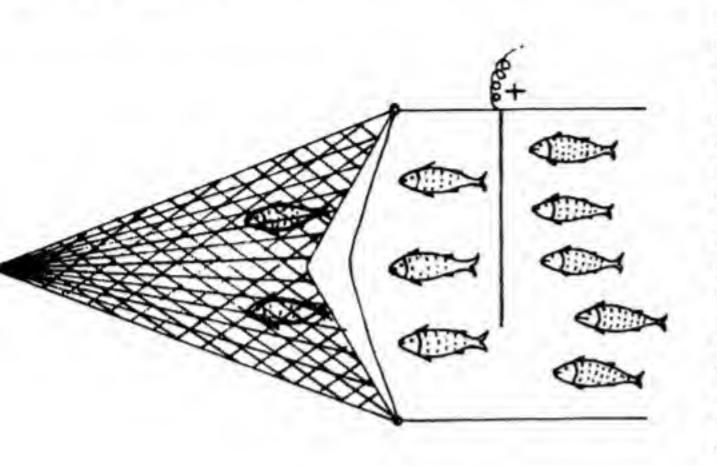


Fig. 2

which undergo physical exhaustion in captivity before death yield poor quality flesh. Such a flesh also deteriorates easily and quickly. In this respect, animals which are slaughtered by a stunning blow on the head yield flesh of the best quality This principle also holds good in the case of fish stunned with electricity. Prawns bury themselves in the mud at the sea bottom, because of which trawling nets fail to catch them. If an energised electrode is suspended in front of the net touching the muddy bottom, it imparts a shock to the prawns buried underneath. consequently jump out and get netted.

Electrical fishing opens a new and promising line of approach before the fishing industry. Even though the initial experiments in this direction were conducted by Germans in the early years of this century, its commercial exploitation commenced only in the past two decades. Developed countries like Germany, U.S.A., Canada, U.S.S.R., etc., have already started large scale application of the method, but it is still in experimental stages in our country.

T. K. GOVINDAN

Central Institute of Fisheries Technology Substation, Kakinada-533002.

(A. P.)

1500 years, but has received little scientific attention. Recently, David R. Criswell of the Lunar Science Institute in Houston, Texas and some other researchers (Scientific American, May 1976, p. 61) conducted the first ever quantitative analysis of an acoustic dune, the Sand Mountain near Fallon, Nev., which has often been heard to boom. The research group recorded the vibrations transmitted through the sand by a geophone and the sound through the air by a microphone. After trying several methods, it was revealed that the sand boomed loudest when a trench was rapidly dug in it with a flat bladed shovel. Interestingly, the sound was like a short low note of a cello and lasted for less than two seconds, laudable at a distance of 30 meters. It was found that booming could also be produced by pulling the sand down the hill with the hand. In doing so, strong vibrations similar to mild electric shocks were felt in the finger tips. On disturbing the sand, the sound detected by the air microphone was about a quarter of a second before seismic vibrations detected by the geophone. Stopping the sand disturbance resulted in simultaneous loss of both types of vibrations, viz., seismic and acoustic.

Apparently, however, booming sand dunes are indistinguishable from ordinary silent dunes. But the examination of sands under scanning electron microscope has revealed that the individual grains of booming sand are more highly polished than the grains of silent sand. Except two booming dunes at Hawaii which are principally calcite, the 29 of the total 31 known booming dunes The are primarily of quartz sand. experimenters comment. however, that the booming process is intriguing and far more complicated than what is presently explained by a quantitative theory.

ZAKA IMAM

Booming sand dunes

IT would seem a paradox that sand dunes can produce noise. But the fact is that dunes in many

parts of the world squeak, roar or boom. The phenomenon has been described in desert legends for atleast

The safe and unsafe periods

A TTEMPTS to avoid conception by the practice of timed periodie abstinence have been undertaken in many societies. The most common of them involves the avoidance of intercourse before, during or after menstruation. Variations of this practice have been reported from ancient Rome to Nandi of East Africa via the Indian cultures of New Mexico. The Bishop of Amiens had asked the Sacred Penitentiary how he should deal with those couples amongst his flock who were confining intercourse to the tempus ageneseos, and not to interfere 'so long as they do nothing to impede conception'. Allbutt, in The Wife's Handbook, advised abstention from intercourse from 5 days before to 8 days after menstruation. This was repeated by almost every subsequent writer until the 1930s.

Menstruation and conception

Let us consider first the physiology of a woman's monthly cycle and conception. After puberty, a woman undergoes a regular cyclic change in the reproductive organs during her fertile period. The uterus undergoes various phases like resting phase, proliferative stage, pre-menstrual phase and menstrual phase which last for about 5 days (1st to 5th), 9 days (6th to 14th), 14 days (15th to 28th) and on 28th day respectively. In the menstruation period the uterus sheds its lining with blood, mucus and certain other substances. In the proliferative stage new linings are formed. Just after the completion of the proliferative stage, the ovary expels only one ovum per cycle which becomes available for

fertilization only for 24 hours. Once spermatozoa have entered the uterus, they can remain viable for 48 to 72 hours. There is a minimum period of 4 days in each cycle when conception is possible theoretically. Pregnancy can therefore be avoided if intercourse is omitted during this time.

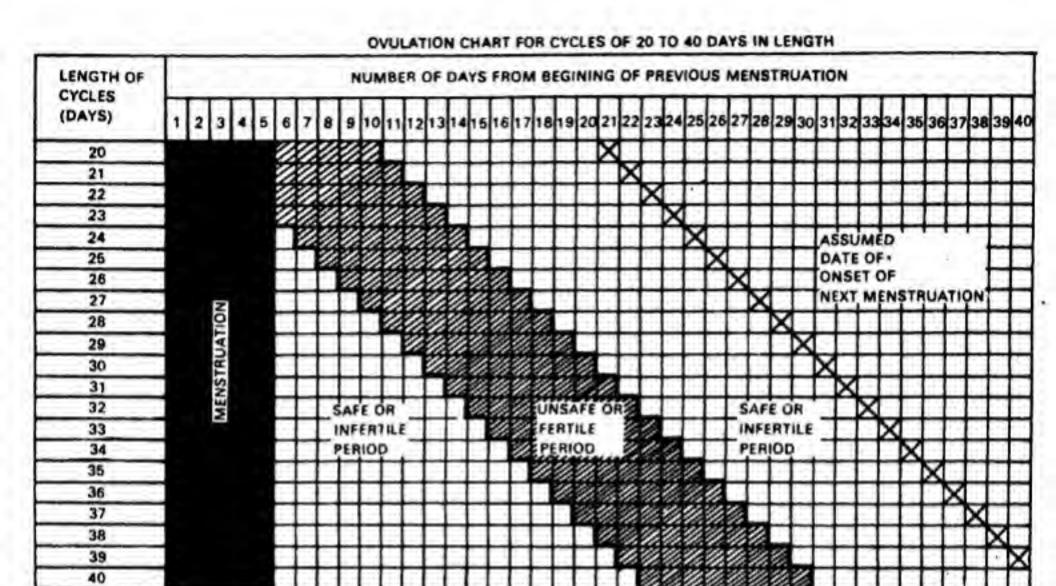
Calculating the 'safe' and 'unsafe' days

When the cycles are regular. It has been assumed that ovulation in a normal cyclic woman would occur on 14th day before the next menstruation. For practical purposes, days 12 to 16 (always counting backwards from the expected date of next menstruation) are regarded as possible ovulatory days. To these are added days 17 and 18, for previously deposited spermatozoa, and day 11, which represents the limit of ovum survival. These 8 days, i.e., from day 11 to 18, have been recommended as a fertile period. Safe and unsafe period in a woman, whose cycles are regular in the range of 20-40 days, can be calculated with the help of Fig. 1. For instance a woman whose monthly cycle is of 29 days, days from 12th to 19th constitute the unsafe period.

When the cycles are not regular. In the case of a woman whose cycles are not regular, the difference in the two infertile phase is most important. For this, it is enough to note only the earliest possible and the latest possible dates on which the next period would occur. These are obtained by calculating back data from at least six past menstrual cycle record.

Table 1. Table shows how to calculate safe and unsafe periods in the case of a woman whose cycles are not regular

l ength of shortest period	First unsafe day after start of any period	Length of longest period	Last unsafe day after start of any period
20 days	2nd day	20 days	9th day
21 days	3rd day	21 days	10th day
22 days	4th day	22 days	11th day
23 days	5th day	23 days	12th day
24 days	6th day	24 days	13th day
25 days	7th day	25 days	14th day
26 days	8th day	26 days	15th day
27 days	9th day	27 days	16th day
28 days	10th day	28 days	17th day
29 days	11th day	29 days	18th day
30 days	12th day	30 days	19th day
31 days	13th day	31 days	20th day
32 days	14th day	32 days	21st day
33 days .	15th day	33 days	22nd day
34 days	16th day	34 days	23rd day
35 days	17th day	35 days	24th day
36 days	18th day	36 days	25th day
37 days	19th day	37 days	26th day
38 days	20th day	38 days	27th day
39 days	21st day	39 days	28th day
40 days	22nd day	40 days	29th day



To calculate safe period in this case, 18 is subtracted from the shortest cycle and 11 is subtracted from the longest cycle. For instance in the case of a woman whose cycles ranged from 22 to 32 days, the safe period would extend upto 4 (22—18=4) and from day 21 (32-11=21) onwards (always counting back wards from the expected date of the next menstruation). The safe and unsafe period in this case can be calculated with the help of Table 2.

experimental animals and there is no reason to believe that it cannot happen in the humans. Furthermore, sometimes in a perfectly regular and normal woman, during the safe period, much of the semen discharged in the vagina is absorbed by its mucous lining, but a part of semen containing live sperms is left there. These live sperms may slowly enter the fallopain tube and remain

dormant until an ovum is liberated many days later. The ovum would then be fertilized by an already existing active sperm. Therefore safe periods are not always safe. It a woman follows 'safe and unsafe chart' strictly, the chances of conception are reduced to a minimum.

ANAND O. PRAKASI School of Studies in Zoolog Jiwaji University, Gwalior-47400

Safe period are not safe

General survey reveals that for about 75 per cent of woman safe periods are safe, but for the other 25 per cent they are not. We are far from sure why the second group does not have safe period. There are a number of reasons worth considering. The excitement of sexual intercourse may cause the liberation of ovum at any time in the 28 days. This has been proved in certain

Oat flakes-a nutritive food

WE are concentrating on growing more wheat and rice, but not much thought is being given to oat cereal. Oat ranks fourth in importance, in world production of cereals, next to wheat, rice and maize. The leading oats producing countries are the U.S.A., the U.S.

S.R., Canada, Germany, France U. K. and Australia.

Oat, an agricultural crop, is grown for its grain and straw in the rabi season which extends from October to December. It can grow on a well drained, rich loamy so but available nitrogen in the so

and the season have a marked influence on the yield and protein content of the crop. In India, oat has so far been grown mainly as a green fodder and to a lesser extent as a grain crop.

Oat contains considerable protein varying from 10%-18%. Oat protein consists of glutenin, albumin, avenine, etc. All oat proteins are rich in amino acids and so play an important role in body growth. They are characterised by their relatively lower carbohydrate and higher fat content as compared to other cereal grains.

Oat has a great potentiality as a feed and is included in the rations of farm animals. Oats are widely used in poultry industry as they attribute significant characters to growing chickens and laying hens. They are an important cereal for turkeys, swine, sheep, dairy cattle, etc.

Oats are superior to other cereals and are considered excellent grain for horses. Oats contain sufficient proteins and so meet the requirement of mature horses, pregnant mares, etc. Their value as a feed especially for race horses is due to the fact that they are not only bulky but nutritive also.

The future of oats as a feedstuff depends on how its special values compare with those of other grains. The feasibility of substituting one grain for another is a constant recurring riddle in feed industry and oats, as such, can steal the show.

Oats as human food

Oats are also processed into foods for human consumption. An important industry based on the production of breakfast foods from oats is still in the initial stages. Keeping in view the importance of oats, one factory in India is manufacturing rolled oats to cater to the needs of the country.

Since only the oat kernel is used for food processing, the adherent husk of the grain which is tough, fibrous and inedible needs to be removed. Out kernel has higher fat content than any other cereal. Lipase, an enzyme responsible for rancidity development, is located almost entirely on the outer layers of the kernel. Its activity sets into a broken or ground kernel depending upon the moisture content, temperature, etc.

Rolled oats

The commercial oats are cleaned and undesirable fractions like dust, dirt, sticks, stones, weed seeds, etc., removed. Clean oats are then subjected to a process of inactivating the lipase in order to prolong the shelf-life of products. Inactivation is accomplished either by steam or acid treatment. Treating with steam is called "stabilization process". Here the oats with a higher moisture content are raised quickly to a higher temperature by injecting steam for a short time. The "wet brushing process" involves the treatment of oats with dilute acids and vigorous scrubbing of kernels with brushes. Preference is mostly given to the stabilization, which not only inactivates the lipase but also has a beneficial effect on the development of characteristic flavour and resistance against rancidity.

After stabilization process, the oats are dried in a kiln where the moisture content is brought down to 6%-8%. Kiln drying improves the keeping quality of milled products. It is responsible for the development of characteristic flavour and improving the organoleptic properties. It facilitates subsequent shelling of the grains by increasing brittleness of the husk.

After kiln drying, the oats are subjected to dry-shelling process. In the conventional method, the kiln dried oats are passed through a pair of large, circular stones where the lower one is stationary and the upper revolves rapidly. The aim of this operation is to obtain maximum

yield of clear, sound, uniform whole oat kernel (groats). For this purpose adjustment between the rollers is so made as to have minimum breakage of the kernel. A relatively recent development in hulling is the use of 'Impact huller'.

The mixture of kernels, huskslivers, groatchips and meals, unshelled oats and fines (flour) is aspirated by air current and passed over various separators and screens where each fraction is separated out. The shelled groats are scoured to detach the fine hair that cover much of their surface and thus are subjected to vigorous 'finishing' separations.

Most groats are milled further into rolled oats of quick cooking type. This is done by cutting the groats in a rotary granulator into 2-4 pieces of uniform granules with a minimum production of flour. They are then called "steel-cut-groats". Steel-cut-groats are next passed through the "cooker" where live steam at atmospheric pressure comes in touch with them just prior to rolling. This treatment softens the groat and makes flaking much easier with minimum breakage or flour formation. The flakes so formed are passed through a drier. After cooling, the flakes are compressed before the pack is seamed or sealed.

Advantages

Most of the dietary essentials are present in the rolled oats, the essential amino acids are present in varying proportions. Minerals such as Ca, P, Mg, Cl, K, Na, Fe, Cu, Mn, Zn, I, F, etc., are also present in rolled oats. In addition, rolled oats contain vitamins like thiamin, riboflavin, niacin, vit. B₁₂, etc., in appreciable amount to promote growth and health.

Rolled oats can be stored easily for a year or more. Waste can be reduced to a minimum, because part or the rolled oats can be used from a tin or a bag and the remainder can be closed or resealed and kept over for another occassion.

Rolled oats can be recommended to recuperating patients whose digestive system has weakened during illness. They will be a great boon in feeding soldiers at the border posts and remote terrains.

Oat flour is occasionally used to make breakfast foods. It can also be an ingredient of prepared canned or dehydrated baby foods. The oat flour contains an anti-oxident, probably allied to tocopherol or phospholipid, that retards the development of rancidity. In other countriesmany uses have been found for oat flour. The small quantities may be added or dusted on butter, margarine, peanut butter, roasted peanut or potato chips. It has also been used as a preservative for meat and fish products, candies, powdered egg yolk and doughnut flour.

It is used for coating papers for fatty food containers. It has a great potentiality for use in icecream and dairy products industry.

As the import of oats has tremendously declined, it is of paramount importance to give due consideration to this crop in the agricultural sector. This will not only save the foreign exchange but also provide employment to many people in the country.

A set programme to improve the cultivation of indigenous oats can be launched. A few of the improved varieties like "Kent", "Rapida" and "NP 101", introduced by the Division of Plant Introduction at IARI, New Delhi sometime back, have yet to be popularised among the farmers of the country.

> S. S. LANGAR Senior Executive Dalima Biscuits Ltd. Rajpura (Punjab) 140401

(A. sislana, A. veracuze, A. cantal, etc. used for extraction of fibre, yield workable percentage of hecogenia from its pulp as a by-product. Simil arly, some species of Solanum namel S. khasianum, S. incanum, S. aviculare etc., have yielded glucoalkaloids (ster oid alkaloids), solasodine and sola nine. The active principles in all o them are used as a starting materia for synthesis of steroidal hormone including sex hormones, cortisone other corticosteroids and the active ingredients in the oral contraceptive pill. The continuous search in India has led to the discovery of other two wild plants, viz., Costus speciosus (containing 2.1 per cent diosgenin and Balanites roxburghii (containing 2.2 per cent diosgenin, in 1970 and 1976 respectively. Both have commercial feasibility. Among the plants which bear sapogenins are Trillium govanianum, Paris polyphylla, Cestrum nocturnum, Smilax spp. and Yucca spp.

Costus speciosus—a source of steroidal drugs

THERE is an increasing interest in the acquisition of new plant materials as a source of industrial raw material. It is almost always easy to develop a natural plant ex- compounds which could be converttract than to synthesise a complex ed into cortisone. The search led to molecule in the laboratory. Experi- the discovery of the corticosteroids ence suggests that natural materials in some plants. In India, some plants still serve as better model and eco- such as Dioscorea deltoidea and D. nomic source even for a new and possibly improved synthetic drug. Governments and pharmaceutical firms in the Western Countries organise extensive survey of potentially rich geographical regions. Several hundred thousand dollars are spent annually on the screening of plant resources and the results in many cases have been rewarding.

The discovery of cortisone as a remedy for rheumatoid arthritis led to a worldwide search for plants containing cortisone or other similar prazeri have respectively yielded as high as 4.8% to 8.0% and 2.0% to 4.0% diosgenin. The introduced varieties, viz., D. composita from Mexico and D. floribunda from Central America have been acclimatized and the one-year-old plants produce as much as 2.5% to 3.0% and 2.0% to 3.0% diosgenin respectively. Some of the Agave spp.

Conversion of sapogenins

R. E. Marker and his associates have discovered that steroidal sapogenins are readily converted into pregnana compounds with the desirable hormonal side chain. At first only steroids in which 11oxygen could be introduced chemically were useful. They were hecogenin with a 12-carbonyl group and diosgenin with unsaturation between carbon 5 and 6. Later, it was shown that progesterone could be converted microbiologically into 11-a-hydroxy progesterone. Solasodine is converted into 16-dehydro prognonolone acetate (16 DPA). So all progesterone precursors are potentially valuable and diosgenin is the most important gain.

Steroid consumption in India

Demand for steroida drugs is increasing Costus speciosus, like other steroidal drug-yielding plants, can meet this demand to some extent. A number of leading pharmaceutical manufacturing companies have taken keen interest in the manufacture of steroid hormones in India. The steroid intermediates produced from diosgenin, besides meeting internal requirements, are already being exported to a large extent.

Costus speciosus Smith (Fam. Zingiberaceae), locally known as "Keu", has recently gained importance as a plant which may provide the indigenous steroid industry with a supplementary raw material for production of diosgenin. It has attracted attention of its high potential for the yield of rhizomes and of diosgenin.

It is an erect, perennial, stout herb with a long and leafy stem attaining a height of 120 cm to 170 cm. Rootstock is rhizomatous and flowers are white.

The plant is distributed throughout India and is excessively found in West Bengal plains, particularly in Gangetic belts, in wild forests. In its natural habitat the plant grows in moist and shady places. The plant generally sprouts in May, flowers during August/September and fruits mature in October/November in natural condition.

Diosgenin content

In 1970, Das Gupta and Pandey reported 2.12 per cent diosgenin in alcoholic extract of Costus. In 1974, Sarin et al. isolated 2.3 per cent of the same component in H₂SO₄ acid hydrolysis extract. They again (1976) reported that there is a definite plant to plant variation of the content and with the agro-climatic conditions of the zone of natural occurrence. The range of diosgenin contents between plants varies from 0.32% to 3.36%. The content is maximum (about 3.30 per cent) in July when the plant is in early flowering stage. It is minimum in December when dormancy sets in.

Cultivation techniques

The plant, Costus speciosus, is a valuable recent discovery and should not be allowed to be depleted like Indian Dioscoreas by herb gatherers. Government of India as well as State Governments should keep an eye on this valuable Indian plant to prevent its depletion and should encourage its cultivation as a regular crop in forest areas and Government farms, because the natural resources are limited.

Marketing

A number of drug companies using diosgenin as a raw material have showed interest in *Diuseoreus* grown on contract basis and the author believes this interest can also be assumed in cases of

Costus. On the prevailing basis, a profit of over Rs. 10,000/ha/year can be expected. A good crop, however, can give as a high profit as Rs. 15 500

Popularisation, research and development

The Regional Research laboratory at Jammu has taken steps to improve the condition of this crop. Cultivation trial has also been started in West Bengal Govt. Cinchona Department, Darjeeling.

Some of the future aspects for research and development are enumerated below:

- (1) A comprehensive breeding programme for the genetic upgrading of the diosgenin content of Costus should be initiated by joint collaboration.
- (2) A survey should be made throughout India for the selection of high diosgenin content clones and multiplication of the superior one.
- (3) Various agro-climatic trials should be undertaken to find the suitable regions for cultivation in India to get at a time both maximum herbal yield and active principles.

Senior Res. Fellow Medicinal Plants Lub., Burdwan Univ., Burdwan



NEWS & NOTES

Nobel Prizes 1976

Physics

THE 1976 Physics Nobel Prize has recently been awarded jointly to Dr. Burton Richter, Professor at Stanford University, and Dr. Samuel C. C. Ting, Professor at Massachusetts Institute of Technology (MIT), for their discovery of a new type of elementary particle known as psi or J. The awardwinning experiments of Dr. Richter, who is 45 years old, and Dr. Ting, 40, were made independently of one another at two large particle accelerators. Dr. Richter worked at the Stanford Linear Accelerator Center (SLAC) in Palo Alto, Calidid his fornia, while Dr. Ting experiments at Brookhaven National Laboratory (BNL), Long Island, New York. Drs. Richter and Ting and their colleagues accelerated particles to extremely high velocities and then smashed them into targets to produce a shower of sub-nuclear fragments. The SLAC team smashed electrons and positrons while the BNL team slammed protons against a sheet of beryllium. In each case, the scientists found the same thing : a massive new particle which the BNL team called J and the SLAC called psi. The energy of the J and psi particles was found to be 3.1 billion electron volts-the sum total energy level to

which the smashing particles were accelerated just before the bombardment. The newly discovered particle, announced in November, 1974. was long-lived, as time is measured on the scale of the sub-nuclear world; it existed for 100 billionth of a billionth of a second before decaying into other elementary particles. The new particle has properties that do not show kinship with existing particles. This discovery has opened a new field of research, one that would ultimately reveal whether there was anything further within these particles thought to be the smallest building blocks of matter.

on March 22, 1931 Richter got his B. Sc. and Ph. D. degree in Physics (1956) from MIT. He joined the High Energy Physics Laboratory at Stanford University in 1956 becoming its Professor in 1967.

Born on January 27, 1936 in Ann Arbor, Michigan, Ting spent his childhood in mainland China and his teenage years in Taiwan where his father was a Professor at the National Taiwan University. He came to the U.S.A. in 1956 as a student at the University of Michigan where he did B.Sc. in Engineering (1959), M. Sc. in Mathematics (1960) and Ph.D. in Physics (1962). As a Ford Foundation Fellow he worked in the European Nuclear Research Center in Geneva (1963-64). He then joined Columbia University, becoming Assistant Professor (1965-67) Associate Professor (1967-69). then moved to the MIT becoming Professor in 1969. Dr. Ting now leads with Prof. U. Becker three research groups at BNL, European Nuclear Research Center and the Hamburg Nuclear Facilities.

Chemistry

Dr. William Nunn Lipscomb, Professor of Chemistry at Harvard University since 1959, has been awarded the 1976 Nobel Prize for Chemistry for his studies on structure and bonding mechanisms of compounds known as boranes (hydrides of boron). Boranes are usually unstable (hence are studied at low temperatures) and chemically aggressive, explosive and toxic. They have been tried in rocket fuels. Some boranes have potential applications in polymer chemistry and in the making of strong-fibre materials Certain boranes known as carboranes have promising applications in cancer therapy. Though boranes were known to exist at the turn of this century it remained for Dr. Lipscomb to explain how they were formed, why they existed and what was the nature of their chemical bond. One can find few single fields of inorganic chemistry in which one investigator has dominated so completely as Dr. Lips comb has in borane chemistry. He has been studying borane chemistry since 1949.

Born in Cleveland, Ohio, or December 9, 1919 Lipscomb had B.Sc. degree from the Uni versity of Kentucky and Ph.D degree from California Institute o Technology (1946). Having started his career as an analyst in the office of Scientific Research and Develop ment in 1942 he taught at the Uni versity of Minnesota (1956-59). He moved to the Harvard University in 1959 as the Abbott and William Jame Professor of Chemistry Lawrence and served as the Chairman o Chemistry Department (1962-65) He studied in Oxford University England, as a Guggenheim Fellow (1954-55). Known for his researche on valence theory and diffraction studies of molecules and crystals, Dr Lipscomb spends two-thirds of hi research time studying large pro tein structures using X-ray diffrac tion methods. He has been award ed more than a score of prizes and honorary degrees for his contribu tions in these areas. He was th President of the American Crystallo graphic Association and is a mem ber of the National Academy of Sciences and editor of the Journal of Chemical Physics.

Medicine

DR. Daniel Carleton Gajdusek, Scientist at Bethesda's National Institute of Neurological Diseases and Strokes, and Dr. Baruch Samuel Blumberg. Professor of Medicine and Medical Genetics at Philadelphia's Institute for Cancer Research and the University of Pennsylvania. won the 1976 Nobel Prize for Physiology. Medicine or Dr. Gajdusek was cited for his finding of the cause of a puzzling, fatal degenerative disease called kuru, which long infected the Fore tribe of New Guinea. The agent responsible was found to be a slow virus, in this case, transmitted during cannibalistic rites. Such viruses incubate in the body for years before manifestation of degenerative diseases. The disease kuru first caught the attention of Dr. Gajdusek during a research trip to the South Pacific in the 1950s. After living among the Fore and observing the symptoms (uncontrollable tremors and final total paralysis) he suspected that the disease was an infectious one. He concentrated his studies on the Fore's cannibal ritual of smearing themselves with blood and body tissues of dead relatives and eating some of the remains including brain tissue during a funeral meal. He proved his idea by injecting brain

material from dead kuru victims into chimpanzees. Two to three years later, the animals showed the kuru symptoms. The Fore, long since persuaded to give up their cannibalism. are now almost free of kuru. As stated above, Di. Gajdusek's extensive research has demonstrated that slow viruses like the one that causes kuru can lie dormant in the body for long periods before symptoms appear. The concept of slow viruses may lead to a better understanding of other degenerative diseases of the central nervous system including Parkinson's disease and multiple sclerosis and processes like aging and senility. In 1963, Dr. Blumberg identified a protein in the blood of an Australian aborigine that proved to be closely related to the virus which causes debilitating liver disease, hepatitis B. The 'Australian antigen' was next found in the blood of many persons with hepatitis B. His biomedical detective work led to a method of testing potential blood donors for hepatitis and paved the way for an experimental anti-hepatitis vaccine. The Australia antigen tests in blood banks have already reduced the spread of transfusionborne hepatitis significantly.

Born in Yonkers, New York, on September 9, 1923, Gajdusek received his medical education at Harvard Medical School and further training in Columbia University College of Physicians and Surgeons and Children's Hospital in Boston.

He carried out research in viral and rickettsial diseases in Pasteur Institute, Iran (1954-56), and in ethnopediatrics in Australia and Melanesis (1955-58). Known for his contributions in protein and physical virology. chemistry, mammalian pathophysiology of auto immune diseases and neurological degenerative disorders, human evolutionary studies in isolated populations, child behaviour and development, and patterning nervous' system learning in primitive cultures, Dr. Gajdusek is a virologist at National Institute of Neurological Diseases and Stroke since 1958.

Born in New York on July 28, 1925 Blumberg received his medical degree from Columbia University and Ph.D. degree from Oxford University, England (1957). He was a senior investigator at the National Institute of Arthritis and Metabolic Diseases (1957-59) and chief of genetic section (1960-64). Since 1964 he is with the Institute of Cancer Research and the University of Pennsylvania in Philadelphia.

St. Barnabas Hospital New York 10457 U.S. A

> R. K. DUTTA Beth Isredi Medical Center New York, 10003 U. S. A



How does vomition occur?

EVERY one of us has experienced vomiting but few know why and how it takes place.

Vomition (emesis) is a forceful expulsion of the gastro-intestinal contents through the mouth. It is a complicated and coordinated reflex which can be executed easily by humans, dogs and cats; less easily by swine and rarely by ruminants. Horses almost never vomit unless death is imminent.

During vomition the pylorus and the pyloric area of the stomach contract, the fundus relaxes and the cardia opens; abdominal contraction alongwith thoracic and diaphragamatic relaxation drives the stomach contents into the oesophagus; the oesophagus and thorax then contract forcing some of the material back into the stomach and the rest through the mouth.

Vomiting is a protective mechanism whereby undesirable substances are got rid of quickly from the gastrontestinal tract. But there may be many other deep seated physiological causes for this condition and many times it serves no useful function. Instead, it interferes with orderly physiological processes or complicates therapeutic procedures. Symptomatic relief is occasionally called for and several antimetic drugs have recently been developed.

Neural mechanism of vomiting

Vomiting is induced by stimulation of the vomiting centre located in the medulla (a part of brain). Presently, there is no central emetic agent which could act directly on medullary vomiting centre. Instead, there are numerous possible peripheral afferent sites (peripheral components) or central nervous structures (central components) upon which an agent may act to initiate an emetic response. Vomiting centre can be stimulated in various ways.

Central components. Certain drugs induce vomition by stimulating a specialized area in the medulla known as chemoceptive trigger zone (CTZ), which in turn stimulate the vomiting centre. Various visual, olfactory and psychic factors and certain drugs stimulate vomiting centre through their action on frontal lobes of cerebral hemispheres.

Peripheral components. The vomiting centre can be stimulated by peripheral stimuli. These stimuli include disturbances of the labyrinth (motion sickness), the stimulation of vagal nerve endings in the pharynx, stomach and duodenum and stimulation of sensory nerves to the heart and viscera. The emetic impulses arising from these peripheral sites are transmitted to vomiting centre and induce vomiting.

Morning sickness. Vomiting often occurs in otherwise healthy women during early months of pregnancy. This is due partly to a circulating emetic substance (probably histamine) and partly to pelvic stimulation. Detailed knowledge concerning the etiology of morning sickness is lacking since this condition could not be reproduced in experimental animals.

Radiation sickness. Radiation sickness follows exposure of the body, particularly the abdomen, to ionizing radiations. Nausea and vomiting are the important manifestations of irradiation. Both the CTZ and afferent impulses from the viscera appear to be involved in the induction of vomiting following irradiation. Since CTZ is involved, the presence of a humoral factor must also be seriously considered. In the beginning, the general name "necrohormone" was proposed for the toxic substance liberated from the cells disintegrated under the impact of irradiation. Later, because of its ubiquitous occurrence and the fact that it mimics some of the secondary effects of radiant energy, histamine has been proposed as the substance most likely to act as a necrohormone.

Antiemetic agents

Antiemetics are drugs which are used in symptomatic treatment of nausea and vomiting. The selection of antiemetic agents varies with the type of emetic syndrome. The antiemetic agents can be divided into the following categories

Phenothiazine compounds. Most of phenothiazines have their primary site of action at the CTZ. However, a few of them such as promazine, thiethylperazine, etc., also raise the oral copper sulphate threshold for emesis indicating that they also depress the emetic centre.

Since the phenothiazine derivatives depress the trigger zone, it is not, therefore, surprising that they are most effective in the treatment of vomiting conditions in which the trigger zone is stimulated by circulating emetic substances. The CTZ, however, is also involved in the production of motion sickness, though the phenothiazines are not effective in the treatment of this condition. It is not yet possible to say with certainty why the phenothiazines have no action against motion sickness.

Antihistaminic compounds. Antihistaminics are primarily used in preventing motion sickness. The antimotion sickness properties of antihistaminics may be attributed to their primary action on the vestibulocerebellar pathway or on the cerebellum itself. Their atropine-like properties and opposition of central action of histamine may be the other contributing factors. The most thoroughly investigated antihistaminics are cyclizine, chlorcylizine and meclizine.

Centrally acting anticholinergic agents. Scopolamine and atropine are useful agents for controlling motion sickness. The antimotion sickness properties of these agents may be attributed to their central anticholinergic activity.

Miscellaneous drugs

(a) Trimethobenzamide (Tigan). It

depresses the CTZ, though it is less active than chlorpromazine in this respect. It is said to be useful in the prevention and treatment of all forms of vomiting.

- (b) Diphenidol (Vontrol). It provides an antiemetic action by inhibiting impulse to CTZ and thus has been found useful in controlling vertigo and associated nausea and vomiting in motion sickness and other vestibular disturbances.
- (c) Vitamins. Pyridoxine has been reported to be useful as an antiemetic agent for nausea and vomiting in pregnancy, motion and radiation sickness. It has been shown that in pregnancy, and also following radiation, there is an increased excretion

of xanthurenic acid indicative of pyridoxine deficiency which can be relieved by pyridoxine administration.

(d) CNS depressants. CNS depressants (Barbiturates, choloral hydrate bromides, etc.) have been used to prevent vomiting, particularly due to motion sickness. Their antiemetic activity is probably partly due to direct depressant action on the cortex and the vomiting centre and partly due to their sedative action which induces the traveller to lie down.

SHIVRAJ YADAN S. P. VERMA Deptt. of Pharmacology Haryana Agricultural University Hissar-125004

LETTERS (Continued from page 709)

the former; but, is it not begging the question itself?

ANIL KUMAR GUPTA
Department of Mathematics & Physics
South Point High School
Calcutta-700019

Suggestions

Sir, I read S.R. regularly with keen interest. I liked Meeting future energy demands (S.R., Nov., 1975). Please publish some articles on modern energy sources, especially energy from sea waves and tidal power.

SATEESH R. CHIRPUTKAR
Willingdon College
Sangli

n

Sir, I will appreciate if you publish an article on all aspects of the plant Rauwolfia serpentina based on the latest research results.

S. GOVARDHAN
H. No. 3-13-115
P. C. Hanamkonda
Warangal-506001 (A.P.)

ш

Sir, I am interested in having details on 'Liquid level detectors'. I request you to invite articles on the subject. Liquid level detectors measure level of liquids by using different methods. I would like to

know particularly about electric or electronic type.

> S. S. PRADHAN 'Datta Nivas Tejpal Scheme 4th Road Vile Parle, Bombay

IV

Sir, I request you to publish articles on animal cell organelles especially on nucleus.

AJAI SHANKES
Deptt. of Botans
C.M.P. Degree College
Allahabad-211002
(U.P.



Filariasis — its cause and control

problems in our country. A recnt estimate indicates that approxina ely 12 million people in the counry are carrying the larval stage of
the filarial worm in their blood,
and about 8 million show the disease
n various conditions.

Filaria results from the infection f the lymph dwelling filarial vorm belonging to the phylum Nemathelminthes. Until recently only wo species of the parasites, Wuchereia bancrofti and Burgia malayi vere known to cause the disease in severe manner. W. buncrofti has a vorld-wide distribution, particularly n moist tropics and subtropics. In ndia it is distributed mainly along he sea coast and along the banks of ome big rivers. B. malayi, on the ther hand, is confined mainly to Isia and is very common in rural opulation.

The larval form of W. bancrofti vas first discovered in 1863 by J. Demarquay, a German biologist, in the hydrocele fluid of a man. Later E. J. Wucherer (1866) of England solated them from the urine of infected patients. However, it was to

the credit of W. Bancroft who in 1876 discovered the adult females from an infected person in South America (hence the common name "Bancroft's filaria"). Recently P. C. Basu and his coworkers (1967 to 1970) of the National Institute of Communicable Diseases, Delhi, made an extensive survey on filariasis in India.

The parasite

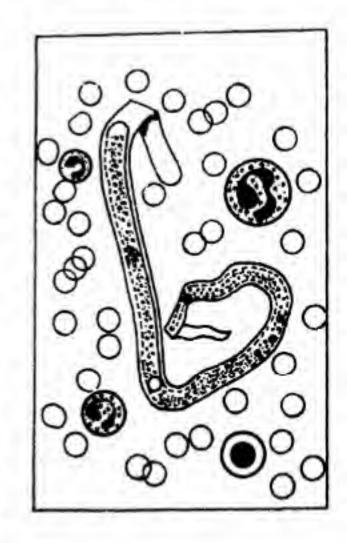
The parasite prevalent in India is W. bancrofti, the adult form of which is an inhabitant of the lymphatic vessels and lymph nodes of human beings only. They are filiform in shape with gradually tapering anterior and posterior ends; the males are much smaller and less in number than the females. The females are ovo-viviparous (i.e., laying eggs with well-developed embryos) and give birth to active embryos called Microfilaria bancrofti (Fig. 1) which, soon after birth find their way into circulating blood by the main lymphatic trunk. The microfilariae may attain a length of about 290 µ and remain enclosed in a chorionic

envelope called hyaline sheath; they do not undergo any further development in the human blood unless they are taken up by the appropriate intermediate host.

Two biologically distinct forms of the parasite have been discovered. In the periodic form, found in India and other oriental countries, microfilariae appear in the peripheral circulation only at night mostly between 10 P.M. and 4. A.M. During day time they remain hidden in the capillaries of different visceral organs, particularly the lungs, heart, kidney, etc. The second form is diurnally sub-periodic, found mainly in Polynesia where it is transmitted by day sucking mosquito vectors. Despite the biological difference, any morphological difference between these two forms has not been reported.

Vectors

Only mosquitos of a few genera are known to be the proved vectors of filariasis. According to an annual report of WHO (1967) the predominant vectors belong to the genera Aedes, Anopheles, Culex and Man-



onia. In India, however, the Culex pipiens complex (particularly Culex pipiens fatigans) is regarded as a najor vector for the transmission of he disease. The exact mechanism by which the vector status of a particular species is determined is still a riddle. E. M. McDonald (1962) of Univerity College of London, U. K. suggested that a particular sex-linked ecessive gene controls the susceptioility of the vector and to some exent the development of the parasite n the body of the intermediate host. Development inside the vector. Enshathed microfilariae enter the stomach of the mosquito from human patients luring its blood meal; within one or wo hours they cast off their sheath and enter the thoracic of the mosquito (by penetrating the gut wall) for undergoing metamorphosis. Within 10 to 12 lays the metamorphosis becomes complete and the larvae attain a ength of approximately 1500μ to 2000 These newly metamorphosed infective stage larvae' migrate towards the proboscis sheath of the mosquito for transmission. The ime taken for the metamorphosis of the microfilariae in the body of the vector varies from two to three weeks depending upon the temperature, humidity of the surrounding environment and to a certain extent on the species of the mosquito.

Vertebrate host

Man is so far the only known vertebrate host of Wuchereria bancrofti. No reservoir host of the parasite has yet been discovered. In 1971, L.R. Ash and J.F. Schacher of the School of Public Health, University of California, U.S.A. reported the occurrence of the worm in the testis region of male birds (Meriones unguiculatus) but the existence of microfilariae in the blood and lymph system of this animal has not yet been confirmed. B. malayi, on the other hand, has been found to de-

velop in a wide range of vertebrates.

One of the most interesting thing regarding filariasis is that in many areas where the disease is endemic, the human females show a considerably lower rate of infection, particularly during child-bearing periods. J.F.B. Edeson (1972) of American University of Beirut, Lebanon suggested that certain male hormones are necessary for a better growth and development of the filarial worm and possibly for this reason occurrence of the parasite is comparatively less This finding has rein females. cently been verified by T. Jung (1974) of the Tribhuban University of Nepal.

When the infected mosquito sucks the blood of a man, the larvae, instead of entering directly into the blood, are deposited at the site of the puncture made during piercing. Latter, these deposited larvae enter into lymphatic channels of the host either by penetrating the skin by their own effort or through previously made wound and settle down at some spot where they undergo further development and sexual maturity. R.H. Wharton (1962) of the University of Cambridge reported that most of the larvae soon after entry into the definitive host seek accommodation in the vicinity of sex organs, particularly to the scrotal lymphatics of males and to the breast or genitalia of the females.

Pathogenicity

Wuchereria infection is commonly known as 'filariasis' or in a more precise sense 'Wuchereriasis which is the result of obliterative endolymphangitis due to certain reaction around dead or dying worms. However, the effect is produced solely by the adult worms present in the lymphatic vessels of the host. The living microfilariae circulating in the peripheral blood are not known to produce any serious pathological

lesions in the host. The main symp tom exhibited by the infection of the worm is an inflammatory reaction in the lymphatic system of the hos which is considered to be the resul of two fundamental pathological as pects; one is lymphoedema, which results due to the accumulation o abnormal and unusual amount o fluid in the affected tissue and the other is elephantiasis, the end resul of Wuchereria infection producing tumour-like solidity due to constriction of afferen fibrotic lymphatics draining a particular or gan. S. Oomen (1969) of Ras Desti Hospital, Jimma, Ethiopia had sugge sted lymphoedema a result of hy pertrophy or fibroplasia of the affect ted tissue due to an increased al bumen containing lymph exudate which impeded the normal flow of the lymph on one hand, and stimula ted the surrounding connective tissue to excessive growth on the other.

Treatment and prophylaxis

Treatment of most of the majo clinical manifestations, e.g., hydro cele, chyluria (escape of chyle through the urine, due to rupture of varicos chyle vessels of the urinary tract and elephantiasis is surgical, but th results of surgical operation on limi and some other organs are ofter disappointing. Other than surgica operations, a vast multitude of drug are also in use to destroy both mi crofilariae and the adult worms Most effective and least toxi drug so far discovered is diethyl carbamazine which destroys almost all the microfilariae and some adul worms when given in adequat amounts. Other than diethylcarba mazine, certain arsenical compound and related chemicals are also know to be effective against the parasit but all of them have some toxi side effects. Mass treatment of affected population in endemic area with diethylcarbamazine has bee bractised in different countries, but due to certain difficulties (i.e., missed doses, febrile reactions, etc.), the progress is not satisfactory. In order to overcome these difficulties many countries (Japan, Indonesia and others) have incorporated the drug in different common and pocular foodstuffs.

Attention has now been directed o eradicate the vectors of filariasis all parts of the world. Unfortunately in India and certain other issues a countries, the progress is not atisfactory because most vector pecies show resistance to all common insecticides. Moreover, rapid urbanization in these countries has far outstripped sanitation and, as a esult, species of the Culex complex are spreading rapidly. For these easons and to minimise the possibility of environmental pollution by insecticides and chemicals, control

of vectors by genetic manipulation seems to be a fascinating and promising practice. The fundamental principle of genetic control of mosquito is to convert the insect into an "autocidal biological control agent". This may be achieved by sterile male technique, producing cytoplasmically incompatible strains, inducing hybrid sterility by chromosomal translocation and sex distortion. The project taken up in India by WHO/ ICMR Unit on genetic control of mosquito (abbreviated as GCMU project) was the largest and most comprehensive in the world. This unit has been able to develop a genetic strain (namely D, strain) with cytoplasmic incompatibility and an integrated strain (namely IS-31B) of Culex pipiens fatigans for this pur-According to a recent report of ICMR, release of these integrated strains in a large scale field trial has

yielded a maximum level of sterility of 50% to 68% among egg rafts laid by the wild females. Moreover, there is much evidence that the level of sterility among mosquitos has decreased village mosquitos population.

Although an avalanche of research work on the cause and control of filariasis has been done in last several years, the severity of the disease is still increasing in parts of Africa and Asia, particularly in India (WHC Report, 1974). However, a multipronged comprehensive and integrated approach has recently been planned in India by Indian Council of Medical Research in near future.

SAMAR CHAKRABART
Department of Zoology
Hooghly Mohsin Govt. College
P.O. Chinsura 712 102
(West Bengal

FOR SURE SELECTION IN I.I.T.

Read

ARUN'S GUIDE

For

INDIAN INSTITUTE OF TECHNOLOGY

(Delhi - Madras - Bombay - Kharagpur & Kaupur)

ENTRANCE EXAMINATION

A guide book covering the complete syllabus as prescribed for the entrance examination of I. I. T. and also based on previous years' question papers 2nd Revised Edition 1977 Price Rs. 25.00

YOUNG MAN & CO. 888 Nai Sarak, Delhi-110006

Phones: Delhi 263298 Jaipur 73972 Bhopal 2500 Copies available with all the leading book-sellers or send your orders direct to the publishers with an advance of Rs. 5.00 by M.O.

Win a Scholarship of Rs. 50,00 per month for three years—May be extended for nine years also.

Read

A Complete Study

to

Science Talent Search Examination

Conducted by

THE NATIONAL COUNCIL OF EDUCATIONAL RESEARCH AND TRAINING NEW DELHI

Containing Questions and Answers on

- (i) Science Aptitude Test
- (ii) Essay Writing
- (iii) Project Report Writing

1977 Edition

Price: Rs. 18.00 (English) Rs. 18.00 (Hindi)

YOUNG MAN & CO.

Govt. Publishers, Nai Sarak, Delhi-110006

Phones: Delhi 263298 Bhopal 2500 Jaipor 73972 Send your order with advance Rs. 5/- by M.O.

[Corrigendem: In SR Nov. 1976 in the above adv. read price of Hindi Edn. as Rs. 18/- for Rs. 8/-]

Science oddities

ALCULATING the exact number of stars in the entire universe would be quite a job, for there are about a thousand million galaxies known to us. No one is really sure how many more there may be. In the Milky way galaxy alone (of which our solar system is a part) there are more than 125 million thousand stars. If you make a list of the names of all the stars in our galaxy only and read them out at the rate of one per second, you will have to read for 4000 years non-stop, before you finish that single list!

A camel can go without water for several weeks, but it loses weight. It can lose up to 25 per cent of its body-weight without getting sick. The animal does not seem to mind this loss in weight, for it can always stop at the nearest oasis and drink enough water to get back its lost weight in exactly ten minutes!

Champion drinker though the camel is, the giant cactus of Arizona, the Saguaro, beats it hollow. Generally a camel can drink about 15 gallons at a time and go without water for a week or so, but the Saguaro, which lives in arid deserts, takes in a ton of water when there

is rain and can manage without another drink for the next couple of years, or even longer!

** ** **

liquid, as everyone knows, normally flows from a higher to a lower level, and the idea of a fluid climbing up the sides of a vessel seems contrary to commonsense, but supercooled Helium does just that. Helium cooled to -271°C actually creeps as a fine film up the walls of its container and flows out at a rate of 30 cm or more per second! This supercooled liquid helium is also an extraordinary conductor of heat and electricity. Its electrical conductivity is practically infinite, for at this temperature it has absolutely no resistance. And it is 200 times as efficient a conductor of heat as copper, one of the best conductors known.

** ** **

"IT is raining cats and dogs" is just a figure of speech, but if we say "it is raining fishes and frogs" it would be literally true, for sometimes it actually does rain fishes and frogs. This may seem baffling, especially if there is no lake with fishes in that particular locality.

What really happens is that the fishes are lifted by a passing tornado from their home waters to considerable heights and over fairly long distances. When the force of the storm is spent, the animals just drop down from the sky!

++ ++ ++

THE longest mountain range in the world is under the sea! If all the water in the oceans were pumped out somehow, the 64,000 km long mid-ocean ridge will stand revealed as a single connected mountain chain, reaching into every ocean in the world. For most part, this immense ridge lies immersed, but here and there the peaks emerge out of water to form islands like the Azores, Ascension, Hawaii, Galapagos, etc. The world's highest mountain is also inside the sea: the twin volcanic peaks of the Hawaiian Islands. Mauna Kea and Mauna Loa rise more than 96,000 m from the floor of the sea. This stupendous height which is almost 900 m higher than Mt. Everest goes unnoticed because the mountain is submerged in water.

INDIRA RAJAGOPAL
Department of Botany
University of Delhi
Delhi-110007

Mathematical puzzle

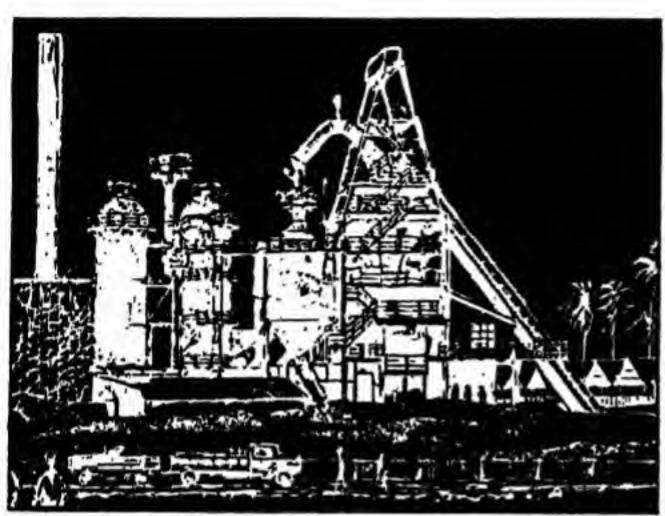
THE number of my ration card is a five digit number, the sum of

the digits being 35. The number reads the same whether read from left to right or from right to left, and is divisible by four. Find the number if only three consecutive digits are used.

B L. ARORA
Physics Department
A R.S.D. College
New Delhi-21

Answer

Since the number is divisible by 4, it must end (and begin) with an even number. As it uses three consecutive digits, there must be two more even digits in the second and fourth place. The only combination which yields a sum of digits equal to 35 is the number 86768.



SCIENCE IN INDUSTRY

Some new chemicals for our farms

A N insecticide called phenthoate has been developed at the Chemical Laboratory lational NCL), Poona. During 1974-75 firm produced 5 tonnes of henthoate valued around Rs. 3 khs. The annual turnover of the lant when fully operational will be pproximately Rs. 2.2 crores. Phennoate is an important organo-phoshorus insecticide having broad pectrum activity against various crop ests of rice, cotton, vegetables, uits, tea and tobacco as well as gainst mosquitos. As it has a low nammalian toxicity, it is safe to andle and leaves no toxic residues fter use.

The Central Fuel Research Institute (CFRI), Dhanbad has developed a multipurpose nitrogenous organic fertilizer from coal. It is a new water-soluble nitrogenous fertilizer. This is called composite ammonium polycarboxylate (CAMP). Field trials at Central Fuel Research Institute and Fertilizer Corporation of India Ltd., Sindri have shown encouraging results.

Pests like insects and moulds attack and damage foodgrains and other commodities in storage. In India where more than 100 different commodities are raised and stored, almost all of them suffer damage due to one or the other causes. For this purpose the Central For Technological Research Institut (CFTRI), Mysore has developed pest-proofing machine which cat treat 3000 bags a day, of 8 working hours.

The treatment of a gunny bag does not take more than a few minute Once treated, the efficacy lasts for 8-10 months.

Pest-proofing of gunny bag prevents cross-infestation from an neighbouring damaged stacks of even from storage areas. The process consists of spraying the insect cidal emulsion on the outer surface of the gunny bag.

Fumigation is a process of using chemicals (fumigants) in gaseous form (fumes) to control the pests of and in the commodities. The Durofume is suitable for large stack fumigation. The 'Minifume' technique (Minifume tablets) is most suitable for small quantities (upto 500 kg).

The pest-proofing of gunny bags the Durofume and the Minifum cost about 10, 15 and 25 paise per quintal respectively. The total cost, therefore, would be 25 paise per quintal for large stacks and 35 paise for small quantities.

Pyrethrum is another insecticid developed by the Central India Medicinal Plants Organisation (CIMPO), Lucknow. It is being produced at present in Kashmir Farm of CIMPO to the extent of about 12 tonnes a year. About 70 tonne of flowers valued at Rs 6.50 lake were imported during 1974-75 to meet the country's demand. Tria cultivation in Kashmir has indicated the yield potential of 700 kg per hectare as against 200 kg.

Another process developed by NCL is for producing maleic hydrazide for controlling the growth of plants.

Maleic hydrazide is used for stopping the sprouting of onions and potatoes in storage; as a suckericide for tobacco cultivation; for in creasing sugar content in the sugar beetroots; for retarding the growth of shrubby trees near high-tension lines, highways and railway tracks, and in reducing the number of mowings of lawns. The shelf life of onions can be doubled by spraying maleic hydrazide solution at a cost of Rs. 3 to 5 per tonne of onions.

CECRI process for calcium gluconate

The Central Electrochemical Research Institute (CECRI), Karaikudi has developed a process for the production of calcium gluconate which is extensively used in the reatment of calcium deficiency, ooth for oral and parentral administration. It is also used as a substitute for fruit acids in the manufacture of fruit jellies and bacing powders, and in the preparation of homogeneous pastes like dentifrices and metal polishes.

The yield of calcium gluconate obtained by the CECR1 technique has consistently been 95% and more.

Calcium gluconate manufactured by the process developed in the Institute has been tested and found to conform to BP/IP specifications.

Ferrous gluconate, which can be made from calcium gluconate, is used in the treatment of iron deficiency, anaemias and in tonic compositions.

Aluminium gluconate also made from certain gluconates has potential use as a tanning agent.

The production of calcium gluconate in the organised sector has been reported to be 309 tonnes in the year 1973-74. The demand for calcium gluconate and ferrous gluconate has been estimated at 520 tonnes by 1978-79. The demand for calcium gluconate alone is expected to rise to 800 tonnes by the end of sixth Plan.

Investigations carried out at the Institute have resulted in an increase of cell capacity, thereby cutting down initial investments on floor space and plant including graphite electrodes.

The capacity of the calcium gluconate plant, as suggested by the Institute, should be a minimum of 100 kg/day or 30 tonnes/year to break even.

BOOKS RECEIVED

- MAN AND ENVIRONMENT By Robert Arvill, Penguin Books Ltd., Represented in India by Penguin Overseas Ltd., 706, Eros Apartment, 56, Nehru Place, New Delhi-110024. Pp. 432, £ 1.25.
- THE CONSCIOUS BRAIN By Steven Rose, Penguin Books Ltd., Represented in India by Penguin
- Overseas Ltd., 706, Eros Apartment, 56, Nehru Place, New Delhi-110024. Pp. 447, £ 1.25.
- OPTIMIZATION METHODS IN OPERATIONS RESEARCH AND SYSTEM ANALYSIS By K.V. Mital, Wiley Eastern Ltd., AB 8, Safdarjang Enclave, New Delhi-110016, Pp. 259, Rs. 15.50.
- REACTION MECHANISM By S.M. Mukherji and S.P. Singh, Macmillan Co. of India, 2/10, Ansari Road, Daryaganj, New Delhi-110002.
- CREATIVE THINKING By Anand Khare, Bablu Books Company, Bangalore-54, Pp. 157, Rs. 40.



WHAT IS SCIENCE FOR? by Bernard Dixon Penguin Books

Ltd., Harmondsworth, Middlesex, England, Pp. 284, UK 85 P Represented in India by: Penguin overseas

Ltd., 706-Eros Apt., Nehru Place

New Delhi-24

CCIENCE and technology are onow presenting a serious dilemma before mankind. Are they good or bad in the long run for the human race? This question has arisen because science and technology have outstripped human imagination in recent years and it is feared by some that they are getting out of hand. From 17th century onwards, science has been making great advances, but it has acquired an unprecedented speed in the past three decades. Man himself did not visualise the consequences of scientific and technological progress in all dimensions. It was a great, hilarious and challenging race to excel in science and technology. Advanced countries enjoyed the thrill of this race without once pausing to think where the "made race" will lead to. The postwar era saw the emergence of highly industrialised nations with unprecedented military prowess. It soon became clear that science and technology were the bedrock of political, economic and military strengths of nations. The demands of science on public and private funds began to multiply. There was no reason not to meet the increasing demands of science for larger funds, because

it gave the governments the powers they needed for internal stability and international influence.

Some social thinkers have begun to take a serious look at science of today, its demands and consequen-These people, Bernard Dixon the Editor of New Scientist among them, are now looking at the seamy side of science: the increasing ecological pollution, the vanishing privacy of individual homes, the dread of drugs and biological weapons, the increasing personal and influence of a few scientists on the governments of their countries. There is hardly an educated public opinion to influence government thinking on expenditure on science, priorities in research and the goals of research.

Bernard Dixon in this book has traced the growth of science and technology since the 18th century and describes how they have influenced the structure of modern industrial societies. The author expresses apprehension that science is becoming more secretive and undemocratic in the advanced coun-His warning is that the untries. hindered progress of science and technology has already created enough problems for mankind. It is time now to make scientific institutions and decision-making in science more democratic, less secretive and more open to public scrutiny. Only through democratisation and openness, the scientific and technological juggernaut can be made answerable to the society.

Dixon's exasperation with the modern fad of some scientists and social thinkers to hold conferences and symposia to form science policy and plans is understandable. He is not alone in thinking that the so-called science policy conferences and science planning seminars are out of tune with the spirit of science. They serve no purpose.

The book provides stimulating reading to those interested in the social aspects of science. THE COMPONENTS OF COMPUTERS by F. F. Mazda, Electrochemical Publications Ltd., 2: Barns Street, AYR VA7 IXB, Scotland, Pp. 100, \$ 28.50.

THE time when the sole calculating instrument at the disposal of an engineer was the slide rule has passed. The construction of gigantic turbines, atomic reactors, high speed aeroplanes and other modern devices has demanded intensive organization of research and the use of mathematical machines for calculations and physico-mathematical analysis.

Mathematical machines may be divided into three classes: analogue computers (continuous action ma chines), digital computers (descrete action machines) and machines o mixed type which embody both ana logue and digital devices. The bool presents a general introduction to all aspects of components used in such mathematical machines. The author, who is the Section Head Technology. Component Rank Development Laboratory begins the book by introducing ana logue, digital and special purpose computers. The computers can be referred to by many names, bu their structure and components are basically analogue of digital. Here the author describes the operating principles of computers and the de velopment in their componentsfrom heads to integrated circuits.

In Chapter 2, the author outlines
the development in integrated circuits where most of the popular
processes are introduced. The
structural differences between the
various types of bipolar, MOS and
film circuit techniques have also beer
given. He mentions that in computer systems the film circuits are not
frequently used, for the required
logic functions can readily be produced by monolithic integrated circuits. The subsequent part is con-

cerned more with circuit techniques than with processes.

A significant feature of the book is that of the twelve chapters four have been devoted only to computer memories. In these chapters, the author discusses basic memory cells. cells, dynamic memories, static random access memories (RAMs) read only memories (ROMs), memory organization and applications. Before examining the characteristics of semiconductor RAMs, the author briefly reviews the meaning of computer memories. According to him, the magnetic core, which is a RAM device, is perhaps the best known of computer memories. The basic construction of various ROM cells has been described.

The amorphous memories are very reliable and these devices have the advantage of being cheap, easyto-process, and are radiation-resistant. The author points out that the switching action of such devices is not yet fully understood, but as a future replacement for semiconductors in computer memories this material holds considerable promise. In the article on Tomorrow's Devices, however, the author writes that these devices will not be used in computers as their processing makes the overall device cost comparable. further adds that they do not show any profound advantage over existing technologies.

A few currently available optical devices which are at present concentrated in the input-output sections of computers are covered in Chapter 8. This is followed by a chapter on auxiliary digital computer devices which are used for data generation, conversion, transmission, storage and display in a digital computer.

The components of analogue computers such as operational amplifiers, function generators, multipliers, sample and hold units of multiplexers are described in two chapters. The chapter on operational amplifiers, which are widely used in many branches of engineering, is dealt in general and can be consulted as a reference source by the concerned personnel.

In the concluding chapter, the devices which are likely to be used in computers of the next decade are introduced.

The salient feature of the book is that more than one third of its volume is devoted to the bibliography, containing about 3000 references which provides further reading material for the topics covered. As many components are widely used in other branches of electronic engineering, at times the subject has been treated in a fairly general manner. This enables the book to attract larger audience.

The book is useful to engineers and market researchers working in component and computer fields.

VUENDER SHARMA
Microwave Laboratory
Department of Physics &
Astrophysics, University
of Delhi, Delhi-110007

FROM VOICE SIGNALS TO SATELLITE COMMUNICATION by B.B. Ghosh, Orient Longman Ltd., 4/5, Asaf Ali Road, New Delhi-1, Pp. 92, Rs. 10

FROM the age man used incoherent noises to the present communication satellites—the entire history of man's efforts to communicate, the author has bound up tightly, and to a fairly good extent, in a small booklet, in 92 pages.

Indeed, the topic is stimulating, one that everybody would be curious to know about. It has been man's long trek—from verbal symbols to satellites. The stories of how signals were of vital importance during battles, how Signora Galvani's soup gave scientists a clue to follow and

build electric batteries, how Oerste found magnetic needle flickering be fore an electric current, how Mors invented telegraph, Bell telephone Marconi wireless, and Baird television, are the milestones covered in the long trek of communication technology.

The background histories of the installation of the first radio station. TV station and telecommunication satellites make the reading interesting. The interposition of biographic of eminent scientists, who made their presence felt in the field ocommunication, and the requisite scientific background at every step make it all the more worthwhile.

The book is, however, not with out faults. It was rather surprising how the author has afforded to miss a chapter on "Interstellar communi cation", in which field our efforts are as awkward and confusing as when the Neanderthal man croaked to get the attention of another man Digressions one frequently comes ac ross; some incidents whose mention would have sufficed are dealt in details, for instance, the evolution of earth and man, J. C. Bose's unrecognised discovery of electromag netic waves, etc. On occasions biographies make dull reading, parti-There cularly so of Sisir K. Mitra. is, in fact, no reason for its becoming so except that there isn't any thing interesting written about him Simply giving a full page on ar Indian scientist-where he was born educated, did research, etc.-does not make his presence felt.

Surprisingly, the book has no biblography. Illustrations are not upto the mark. The size as well as the cover of the book may dissuade many from purchasing it—cover is a crude art work and the size that of a primary school text book. So it is advisable that the buyer should not judge the book from its "face value".

DILIP M. SALW

Did Space Explorers Visit Ancient Egypt?



Recent theory in Archaeology suggests that visitors from outer space landed in Egypt in prehistoric times.

Evidences such as paintings of spaceships, helmeted creatures, curious coincidences in the matching of the Pyramid's dimensions with distances between the planets and the sun and still inexplicable engineering feats involved in building the Pyramids are salient points for this theory.

Nobody can bet on the above theory,
but the Guaranteed Reagents of
Sarabhai M. Chemicals are the
indispensable tools for laboratories to
decipher this riddle and many other
mysteries of modern science.

Our Laboratory Reagents play the
invisible role in all scientific endeavours
from archaeology to oceanography.



SARABHAI M. CHEMICALS

Where scientific tradition of ingenuity never dies